US009134697B2

(12) **United States Patent**
Oshikawa et al.

(10) **Patent No.: US 9,134,697 B2**
(45) **Date of Patent: Sep. 15, 2015**

(54) **POWDER CONTAINER, POWDER SUPPLY ASSEMBLY, AND IMAGE FORMING APPARATUS IN WHICH A POWDER OUTLET FACES IN AN OPPOSITE DIRECTION AS AN OPENING OF A CONTAINER BODY**

(71) Applicants: **Yuki Oshikawa**, Kanagawa (JP); **Emi Kita**, Kanagawa (JP)

(72) Inventors: **Yuki Oshikawa**, Kanagawa (JP); **Emi Kita**, Kanagawa (JP)

(73) Assignee: **RICOH COMPANY, LTD.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/279,923**

(22) Filed: **May 16, 2014**

(65) **Prior Publication Data**

US 2014/0248060 A1 Sep. 4, 2014

Related U.S. Application Data

(62) Division of application No. 13/075,641, filed on Mar. 30, 2011, now Pat. No. 8,755,721.

(30) **Foreign Application Priority Data**

Apr. 1, 2010 (JP) 2010-085101
Jul. 5, 2010 (JP) 2010-152823

(51) **Int. Cl.**
G03G 15/08 (2006.01)
G03G 21/18 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 21/1875*** (2013.01); ***G03G 15/087*** (2013.01); ***G03G 15/0863*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G03G 15/087; G03G 15/0862; G03G 15/0872; G03G 15/0886; G03G 21/1875; G03G 2215/0665; G03G 2215/0692; G03G 2215/0668; G03G 15/0865; G03G 15/0879
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,530,531 A 6/1996 Girard
5,903,806 A 5/1999 Matsuoka et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101387850 A 3/2009
JP 10-63078 3/1998
(Continued)

OTHER PUBLICATIONS

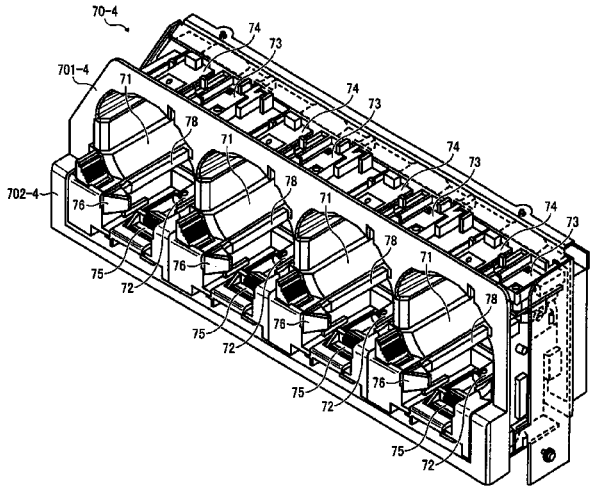
European Search Report issued Jul. 13, 2011, in patent application No. EP 11 15 851.5.
(Continued)

Primary Examiner — G. M. Hyder
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A powder container includes a powder containing compartment having a powder outlet connectable to a horizontally extending tube of an apparatus in conjunction with installation of the powder container in the apparatus, a removably insertable plug member to open and close the powder outlet in conjunction with installation of the powder container, and at least one discrimination protrusion projecting from an outer circumferential surface of the powder container. The powder contained in the powder containing compartment is discharged from the powder outlet thereof to the tube. A downstream end of the discrimination protrusion is positioned downstream from a downstream end of the powder outlet of the powder containing compartment in an installation direction in which the powder container is installed in the apparatus, and at least one of shape, arrangement, and quantity of the discrimination protrusion is unique to the type of powder contained in the powder container.

4 Claims, 41 Drawing Sheets



(52) **U.S. Cl.**
CPC ***G03G15/0872*** (2013.01); ***G03G 15/0886*** (2013.01); *G03G 2215/0665* (2013.01); *G03G 2215/0668* (2013.01); *G03G 2215/0692* (2013.01); *G03G 2221/1654* (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,486,915	B2	2/2009	Koyama et al.	
7,773,920	B2	8/2010	Oshikawa	
7,783,209	B2	8/2010	Uno et al.	
7,962,064	B2	6/2011	Asai	
2004/0052538	A1	3/2004	Yugeta et al.	
2006/0182469	A1	8/2006	Koyama et al.	
2007/0122205	A1	5/2007	Taguchi et al.	
2007/0147900	A1	6/2007	Taguchi et al.	
2007/0147902	A1	6/2007	Taguchi et al.	
2007/0154243	A1	7/2007	Taguchi et al.	
2007/0154244	A1	7/2007	Taguchi et al.	
2007/0160393	A1	7/2007	Taguchi et al.	
2007/0160394	A1	7/2007	Taguchi et al.	
2007/0177886	A1	8/2007	Taguchi et al.	
2007/0286646	A1	12/2007	Ichikawa et al.	
2008/0175628	A1	7/2008	Kita et al.	
2008/0181670	A1	7/2008	Tsuda et al.	
2008/0240792	A1	10/2008	Kita et al.	
2009/0041508	A1	2/2009	Oshikawa et al.	
2009/0080909	A1*	3/2009	Usui et al.	399/13
2009/0087214	A1	4/2009	Utsunomiya et al.	
2009/0103935	A1	4/2009	Uno et al.	
2009/0110425	A1	4/2009	Uno et al.	
2009/0263164	A1	10/2009	Koeda et al.	
2011/0002713	A1	1/2011	Taguchi et al.	
2011/0008075	A1	1/2011	Taguchi et al.	
2011/0286771	A1	11/2011	Taguchi et al.	

FOREIGN PATENT DOCUMENTS

JP	2000-338758	12/2000
JP	2002-91150	3/2002
JP	2004-109367	4/2004
JP	2004-287404	10/2004
JP	2005-241865	9/2005
JP	2005-241868	9/2005
JP	2006-58698	3/2006
JP	2007-140433	6/2007
JP	2008-233667	10/2008
JP	2009-122429	6/2009
JP	2009-211038	9/2009

OTHER PUBLICATIONS

Combined Chinese Office Action and Search Report issued Apr. 16, 2013, in Patent Application No. 201110079609.9.

Japanese Office Action issued Nov. 22, 2013, in Japanese Patent Application No. 2010-085101.

* cited by examiner

FIG. 1

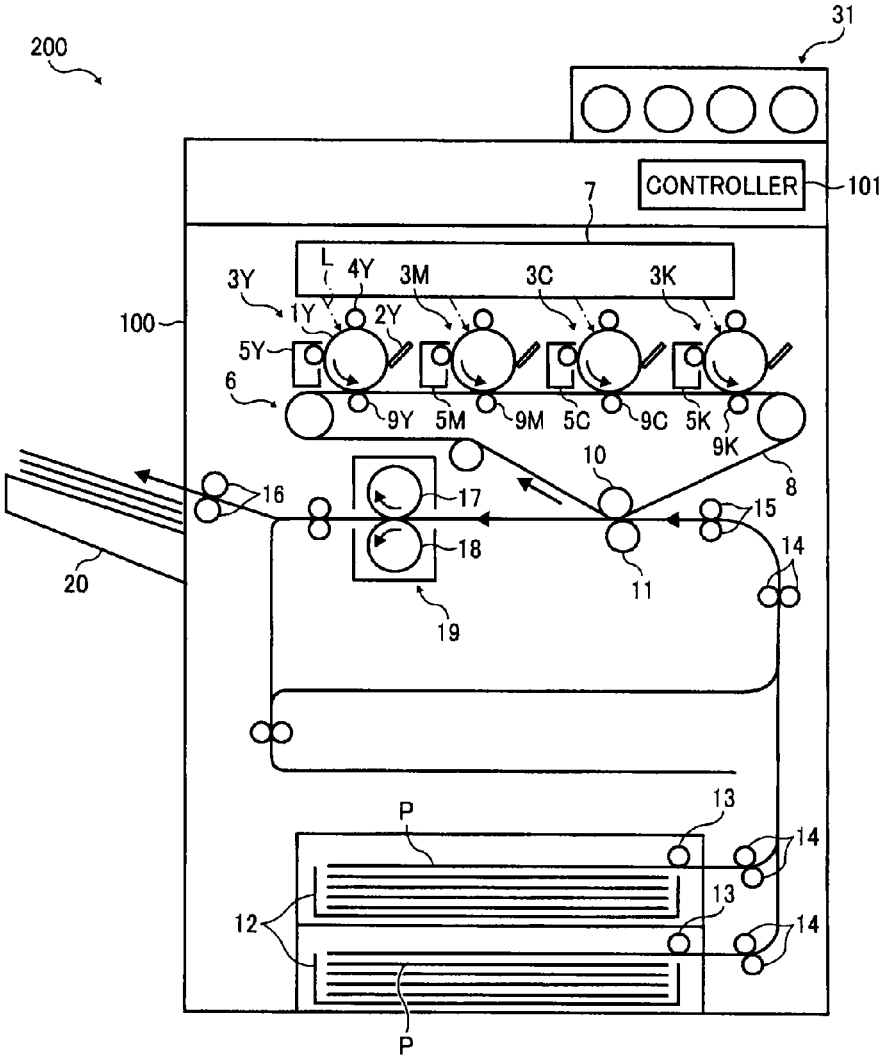

200
31
CONTROLLER
101
7
100
L
3Y
4Y
3M
3C
3K
1Y
2Y
5Y
6
9Y
5M
9M
5C
9C
5K
9K
10
8
16
17
15
18
14
20
11
19
P
13
12
P

FIG. 2

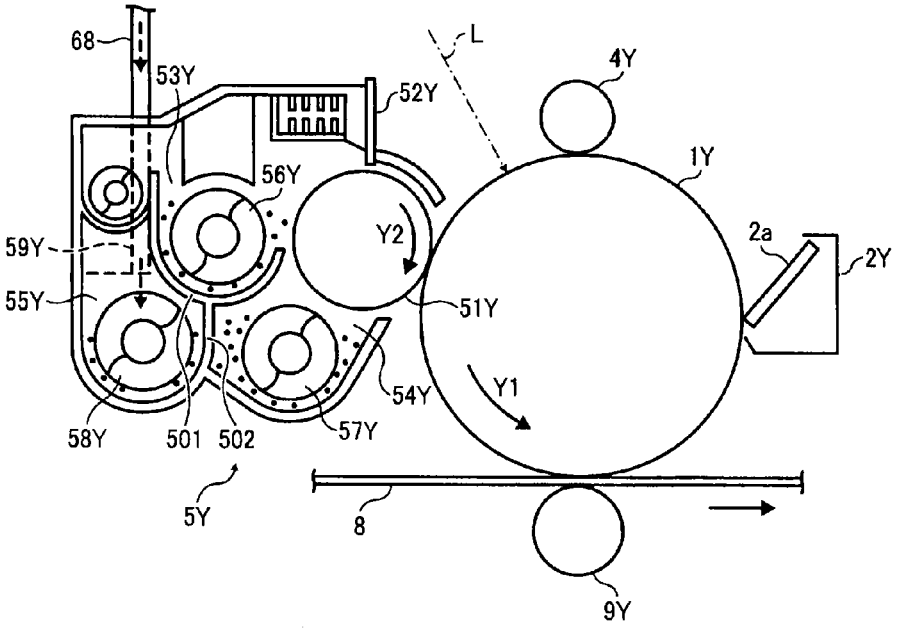

68
53Y
52Y
L
4Y
1Y
56Y
Y2
59Y
2a
2Y
55Y
51Y
54Y
Y1
58Y
501
502
57Y
5Y
8
9Y

FIG. 3

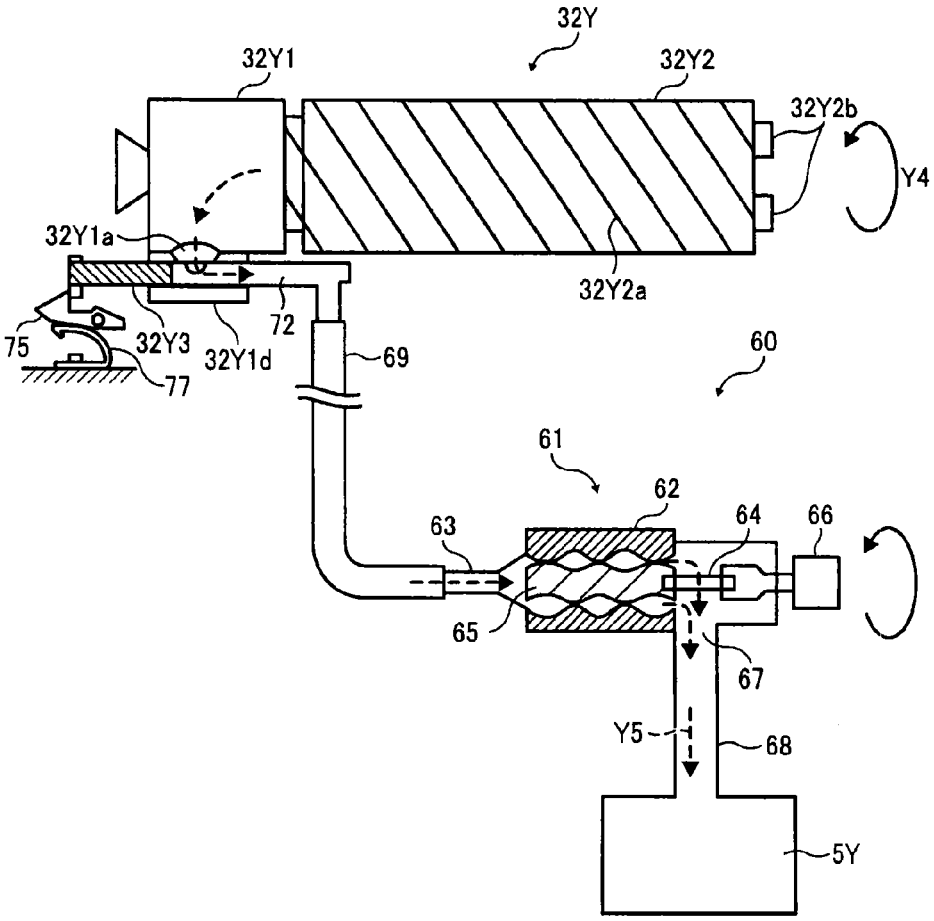

32Y
32Y1
32Y2
32Y2b
Y4
32Y1a
32Y2a
75
32Y3
32Y1d
72
69
77
60
61
62
63
64
66
65
67
Y5
68
5Y

FIG. 4

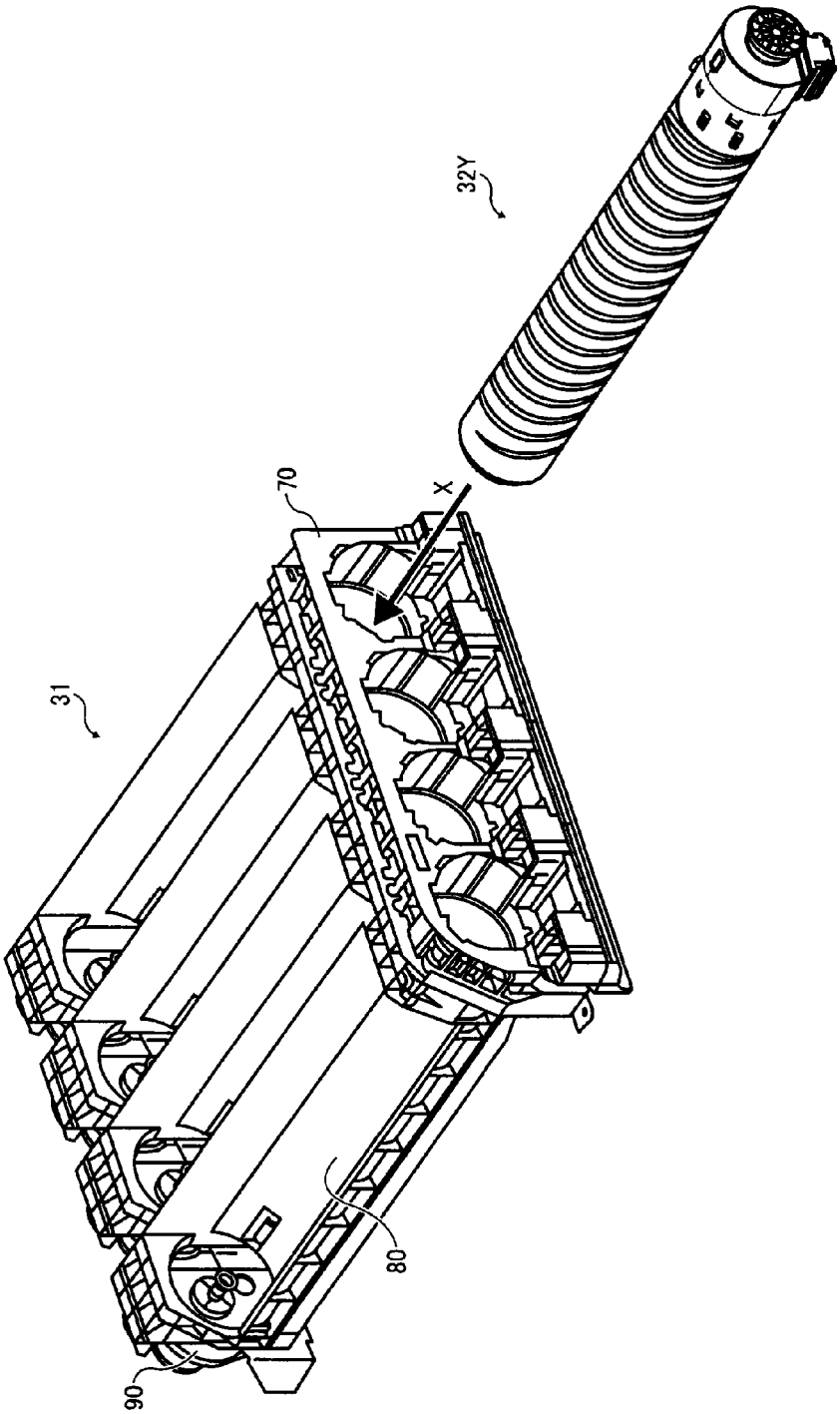


FIG. 5

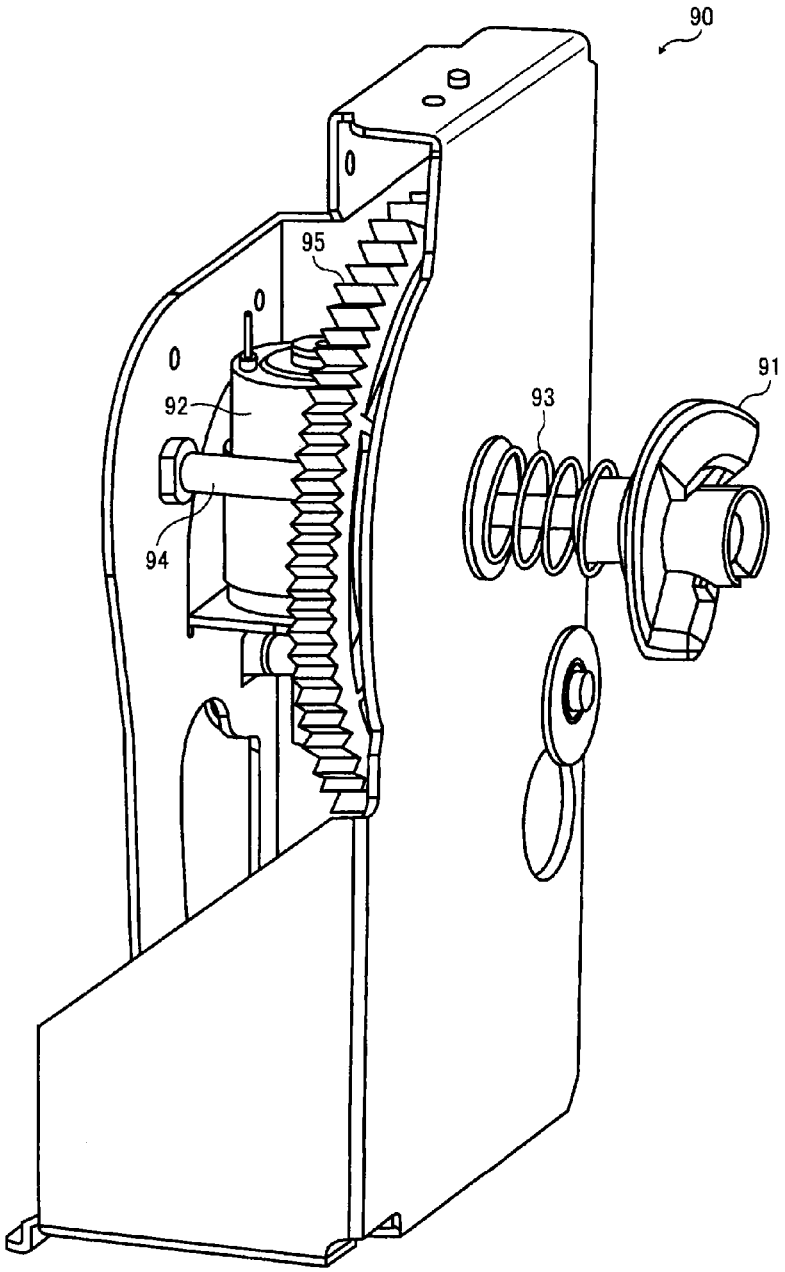


FIG. 6

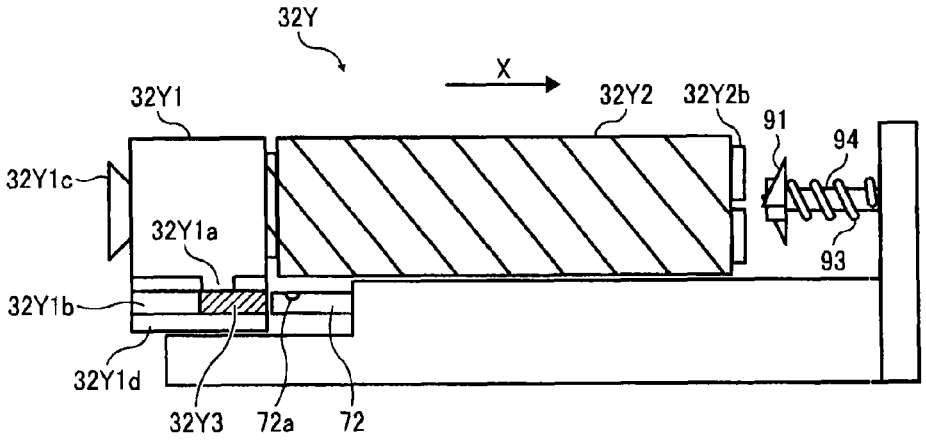
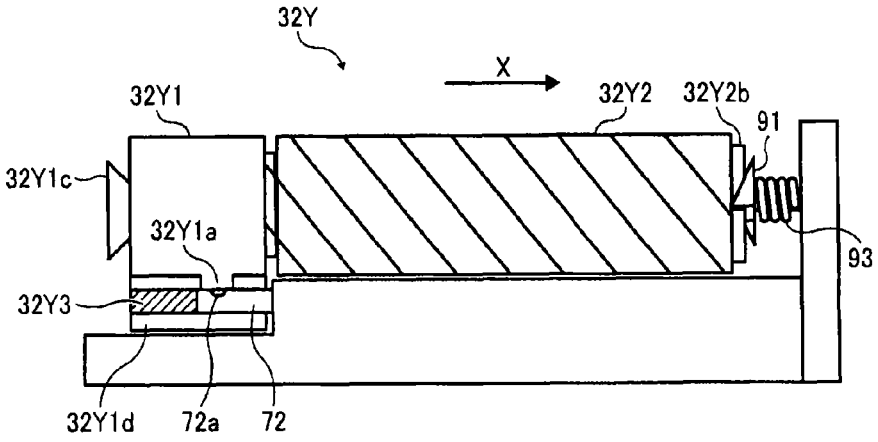

32Y
X
32Y1
32Y2
32Y2b
91
94
93
32Y1c
32Y1a
32Y1b
32Y1d
32Y3
72a
72

FIG. 7


32Y
X
32Y1
32Y2
32Y2b
91
93
32Y1c
32Y1a
32Y3
32Y1d
72a
72

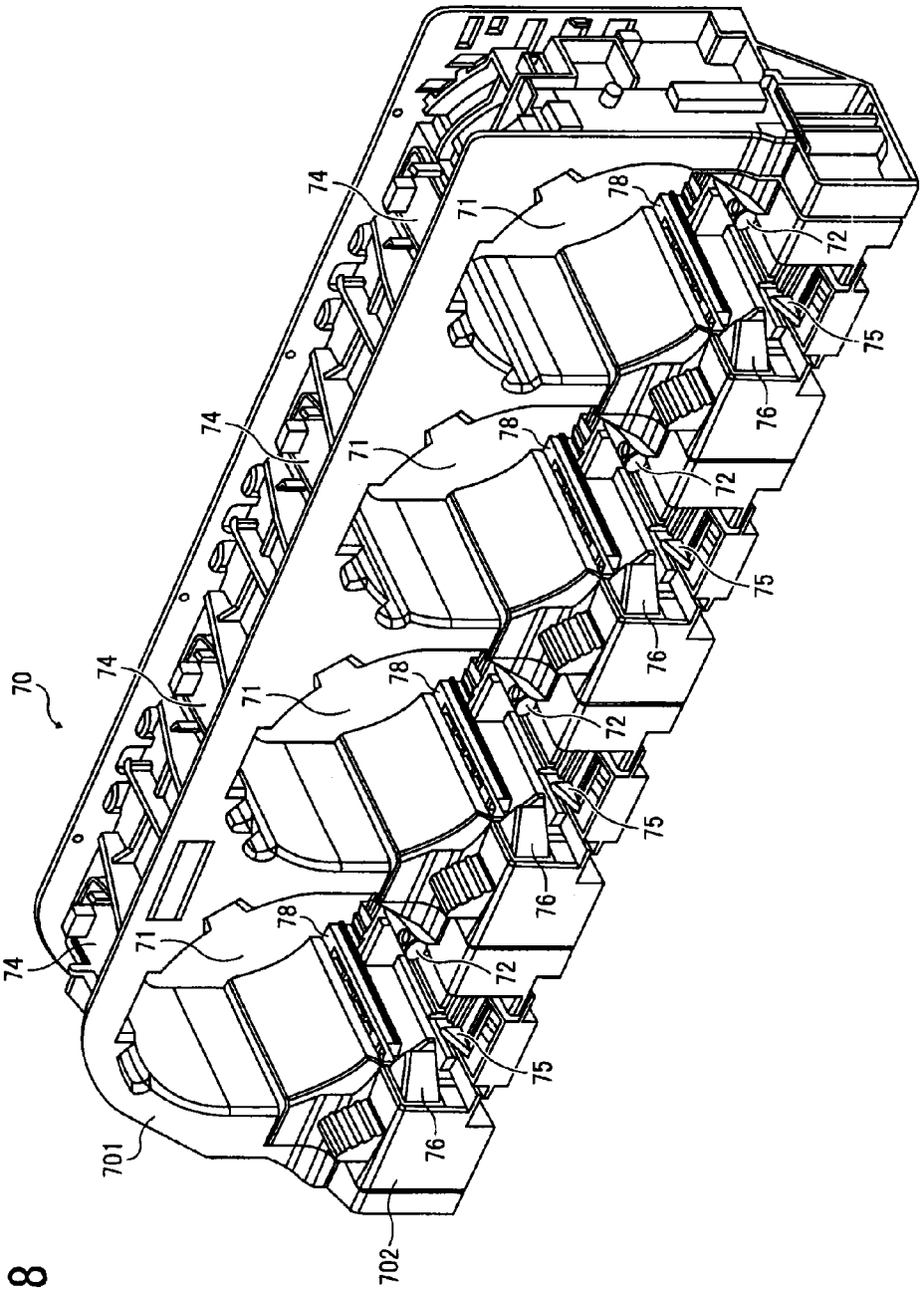


FIG. 8

FIG. 9

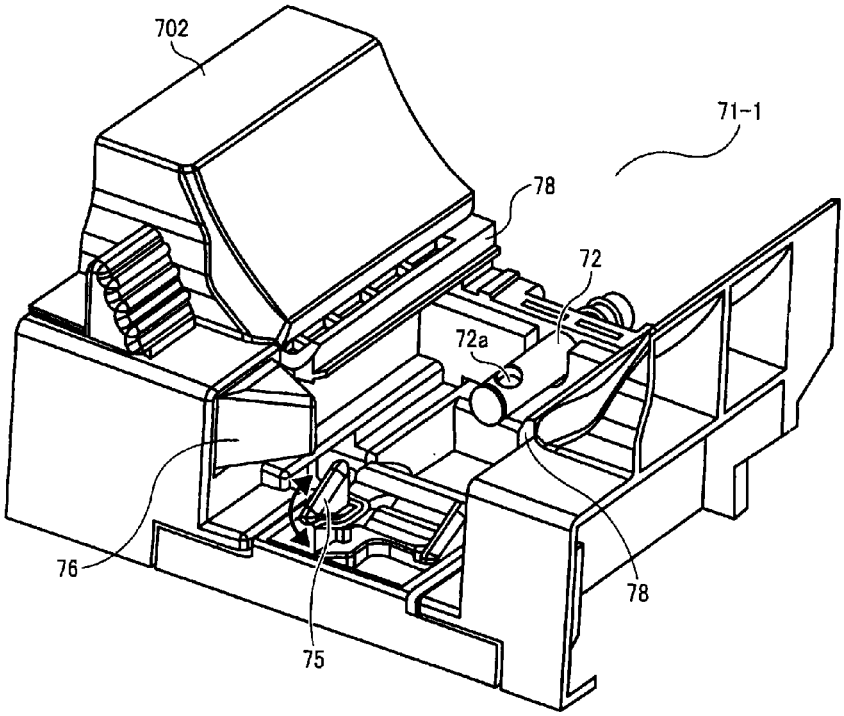


FIG. 10

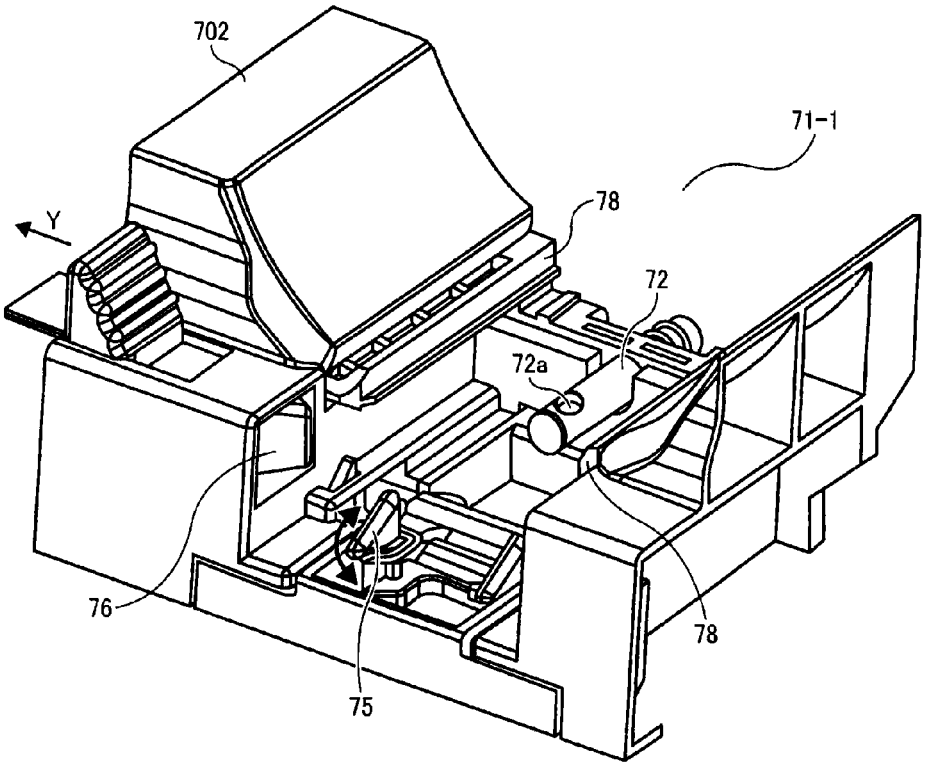


FIG. 11

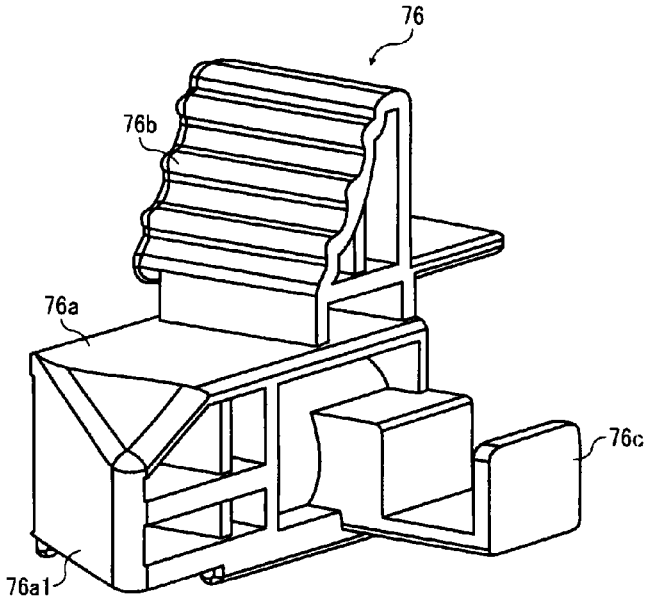

76
76b
76a
76c
76a1

FIG. 12

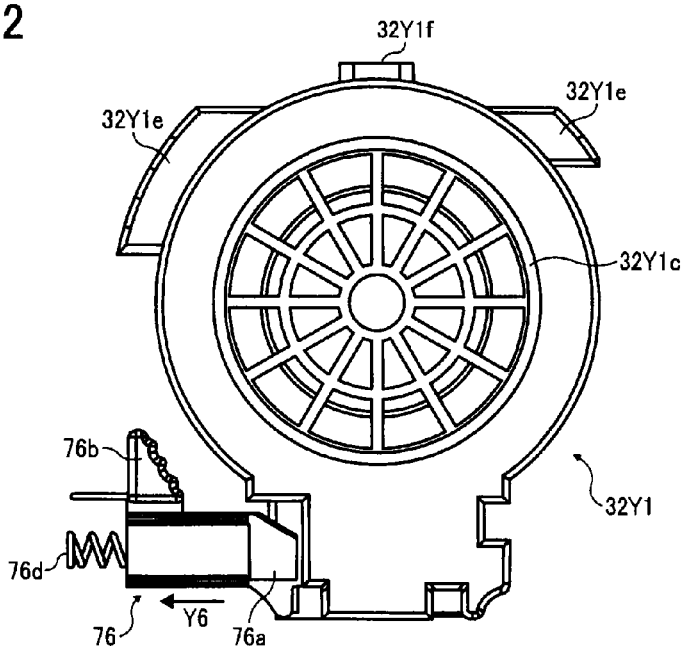

32Y1f
32Y1e
32Y1e
32Y1c
76b
32Y1
76d
Y6
76
76a

FIG. 13

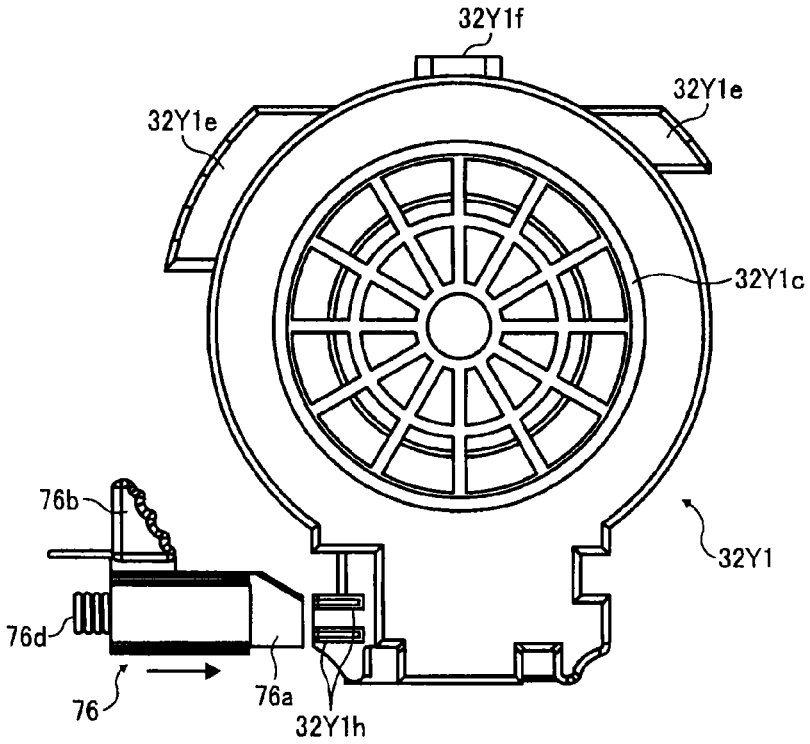

32Y1f
32Y1e
32Y1e
32Y1c
76b
32Y1
76d
76
76a
32Y1h

FIG. 14

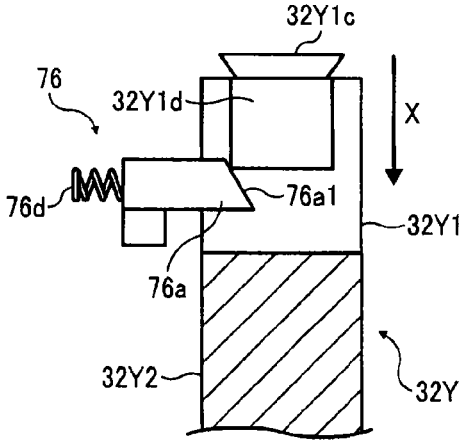

32Y1c
76
32Y1d
X
76d
76a1
32Y1
76a
32Y2
32Y

FIG. 15

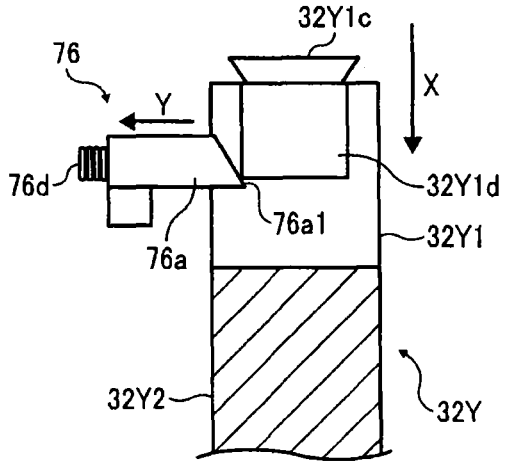


FIG. 16

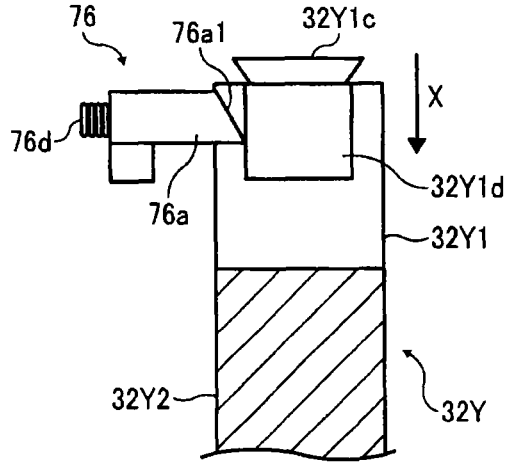


FIG. 17

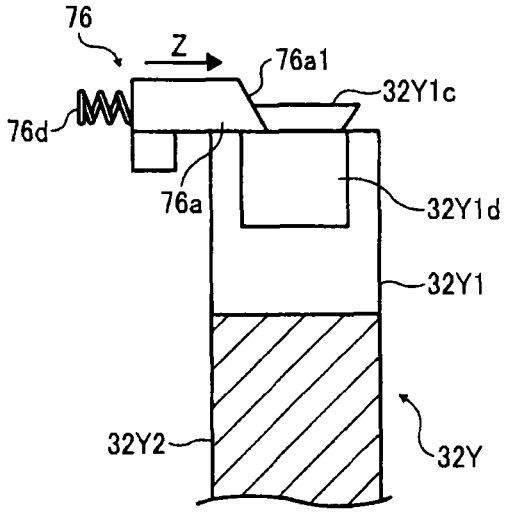


FIG. 18

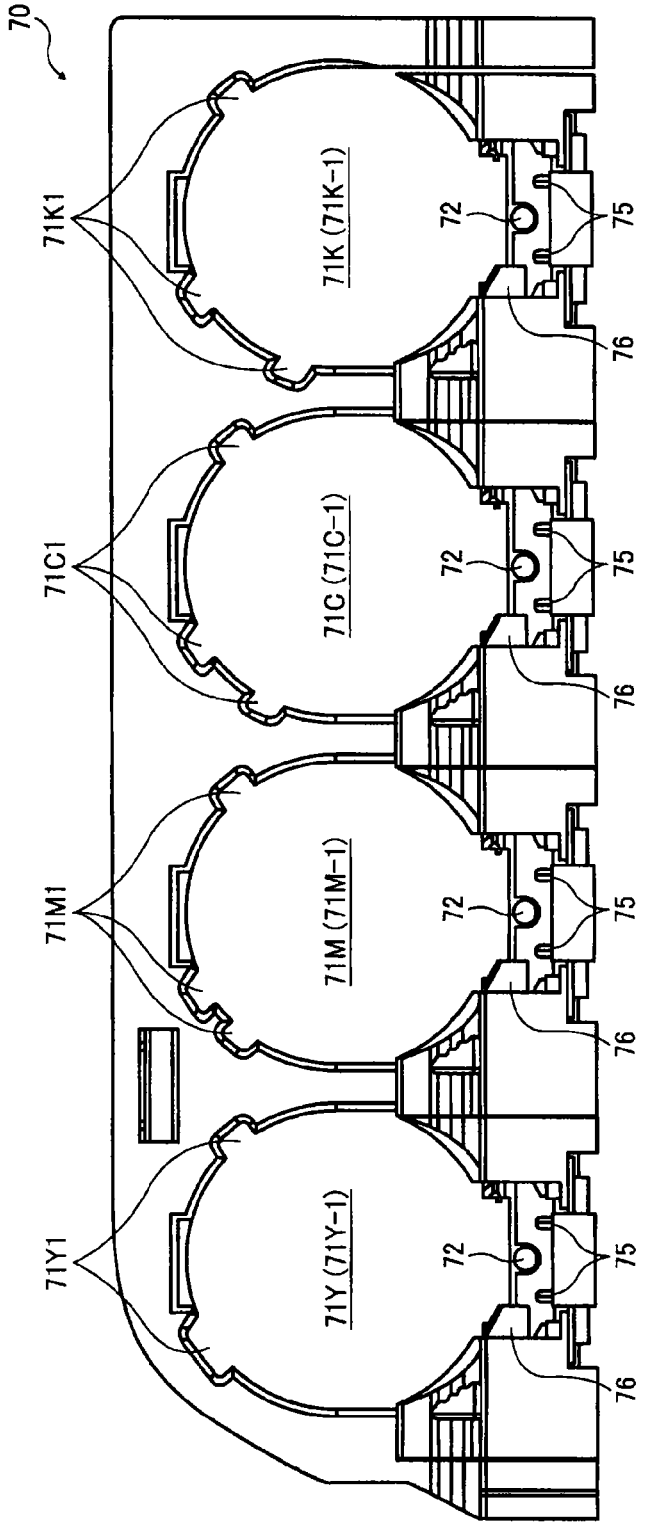

70
71K1
71K (71K-1)
72
75
76
71C1
71C (71C-1)
72
75
76
71M1
71M (71M-1)
72
75
76
71Y1
71Y (71Y-1)
72
75
76

FIG. 19

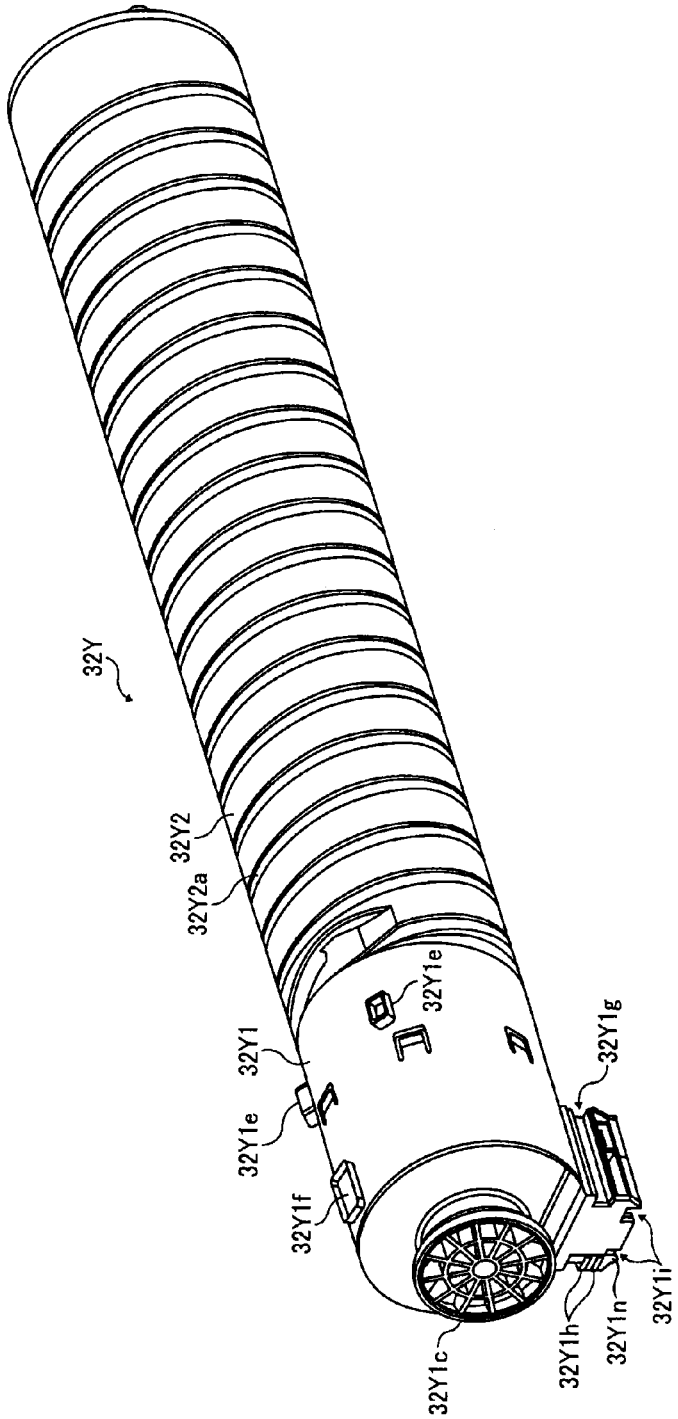

32Y
32Y2
32Y2a
32Y1e
32Y1
32Y1e
32Y1f
32Y1g
32Y1c
32Y1h
32Y1n
32Y1i

FIG. 20

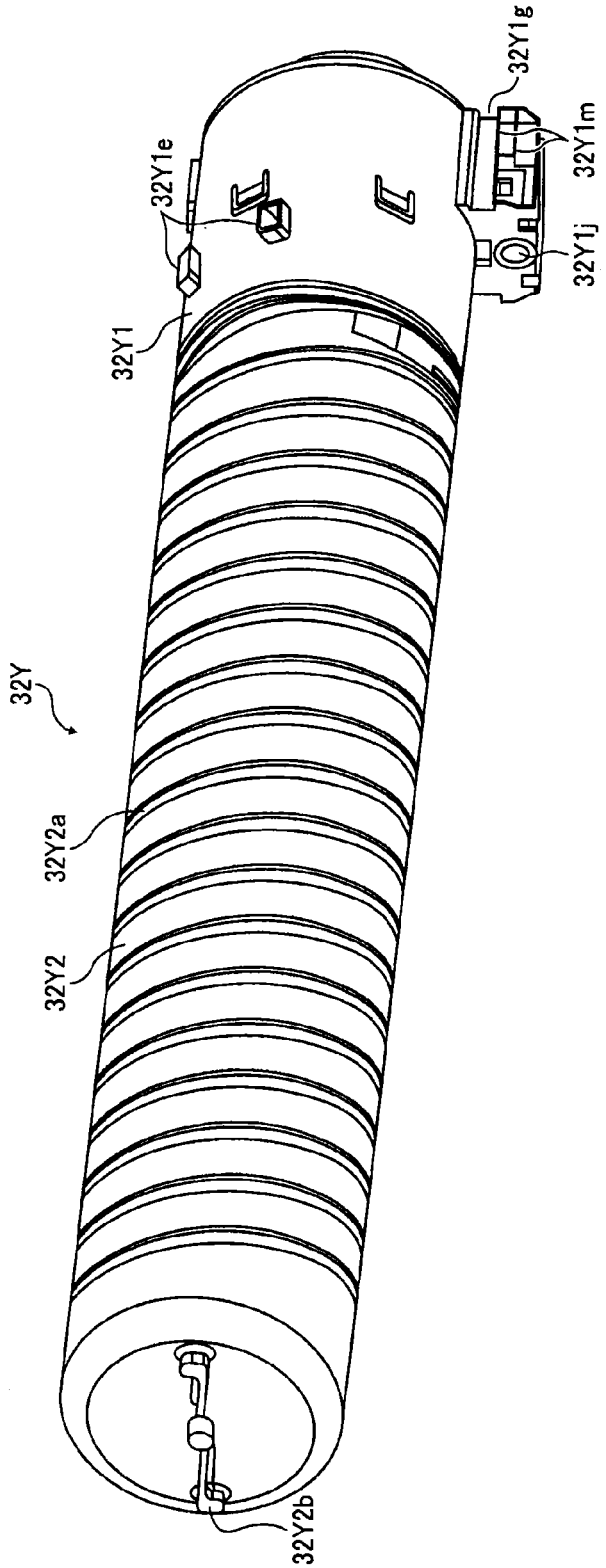


FIG. 21

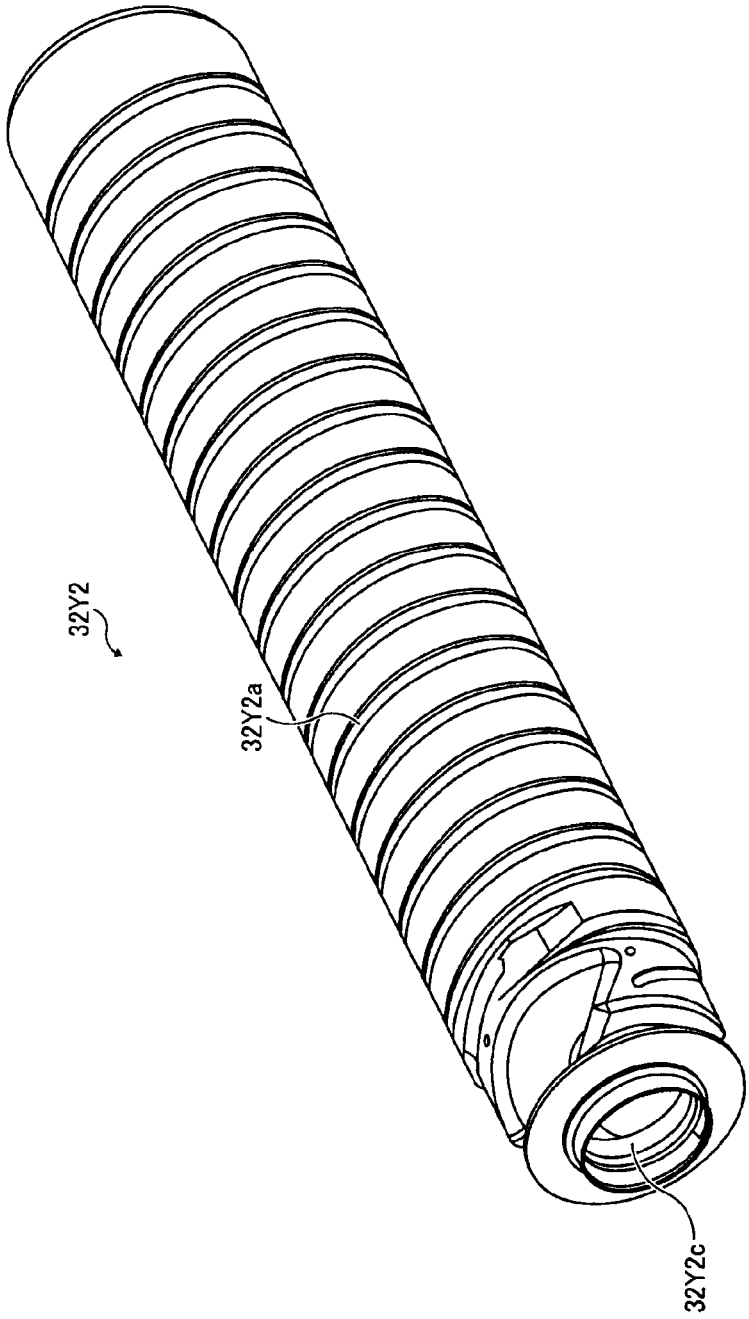


FIG. 22

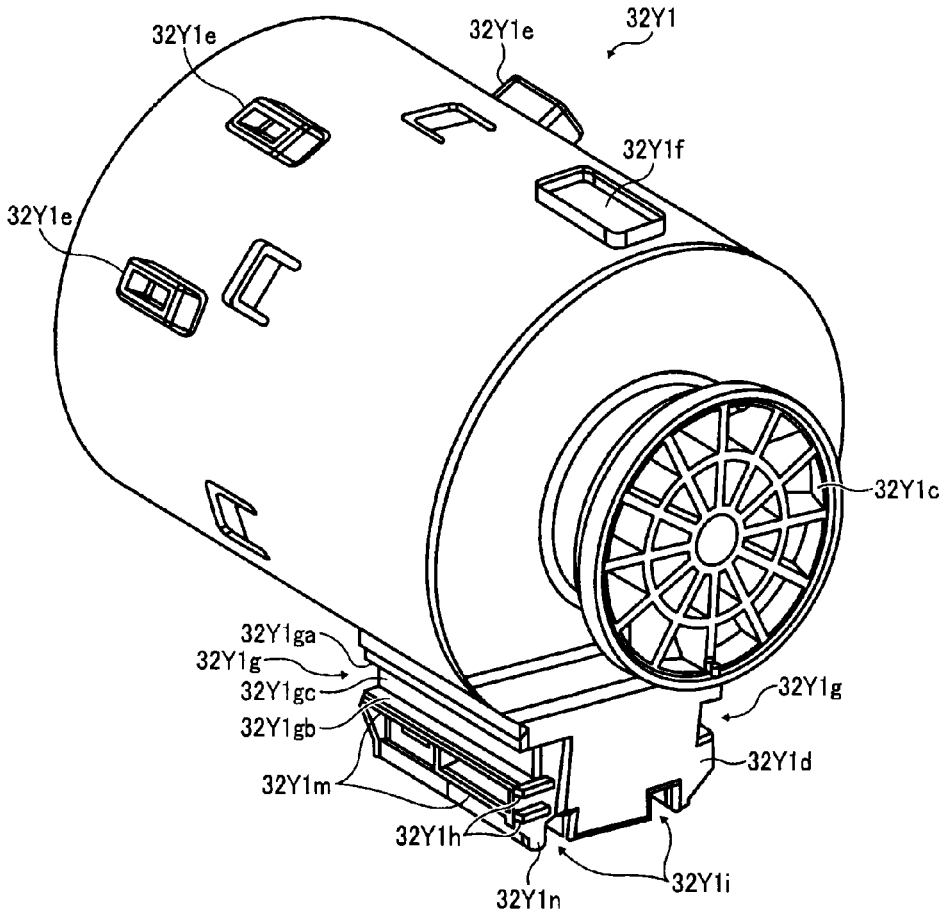
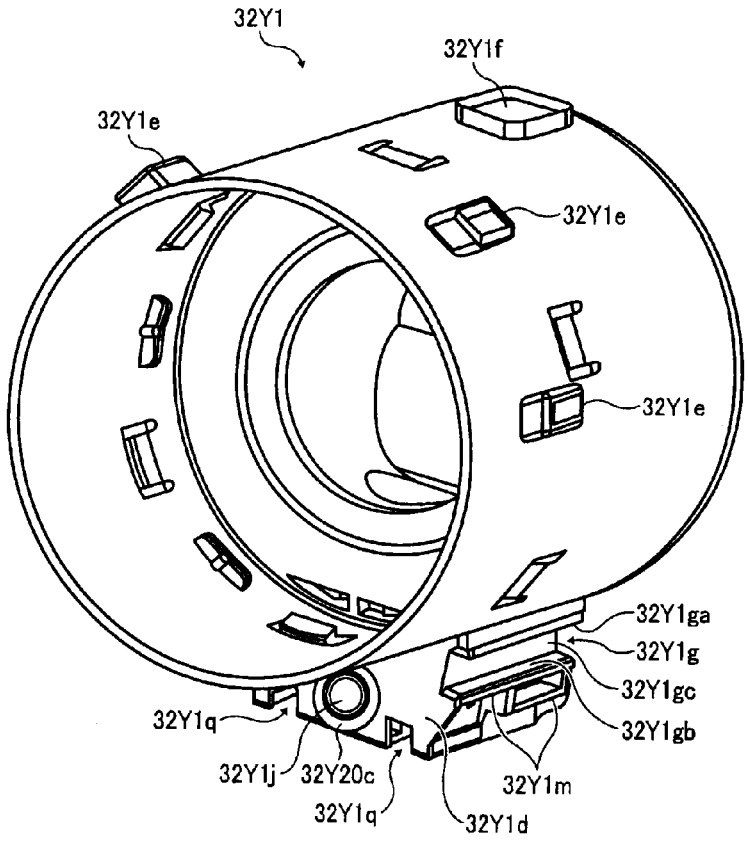

32Y1e
32Y1e
32Y1
32Y1f
32Y1e
32Y1c
32Y1ga
32Y1g
32Y1gc
32Y1gb
32Y1g
32Y1d
32Y1m
32Y1h
32Y1i
32Y1n

FIG. 23


32Y1
32Y1f
32Y1e
32Y1e
32Y1e
32Y1ga
32Y1g
32Y1gc
32Y1gb
32Y1q
32Y1j
32Y20c
32Y1q
32Y1m
32Y1d

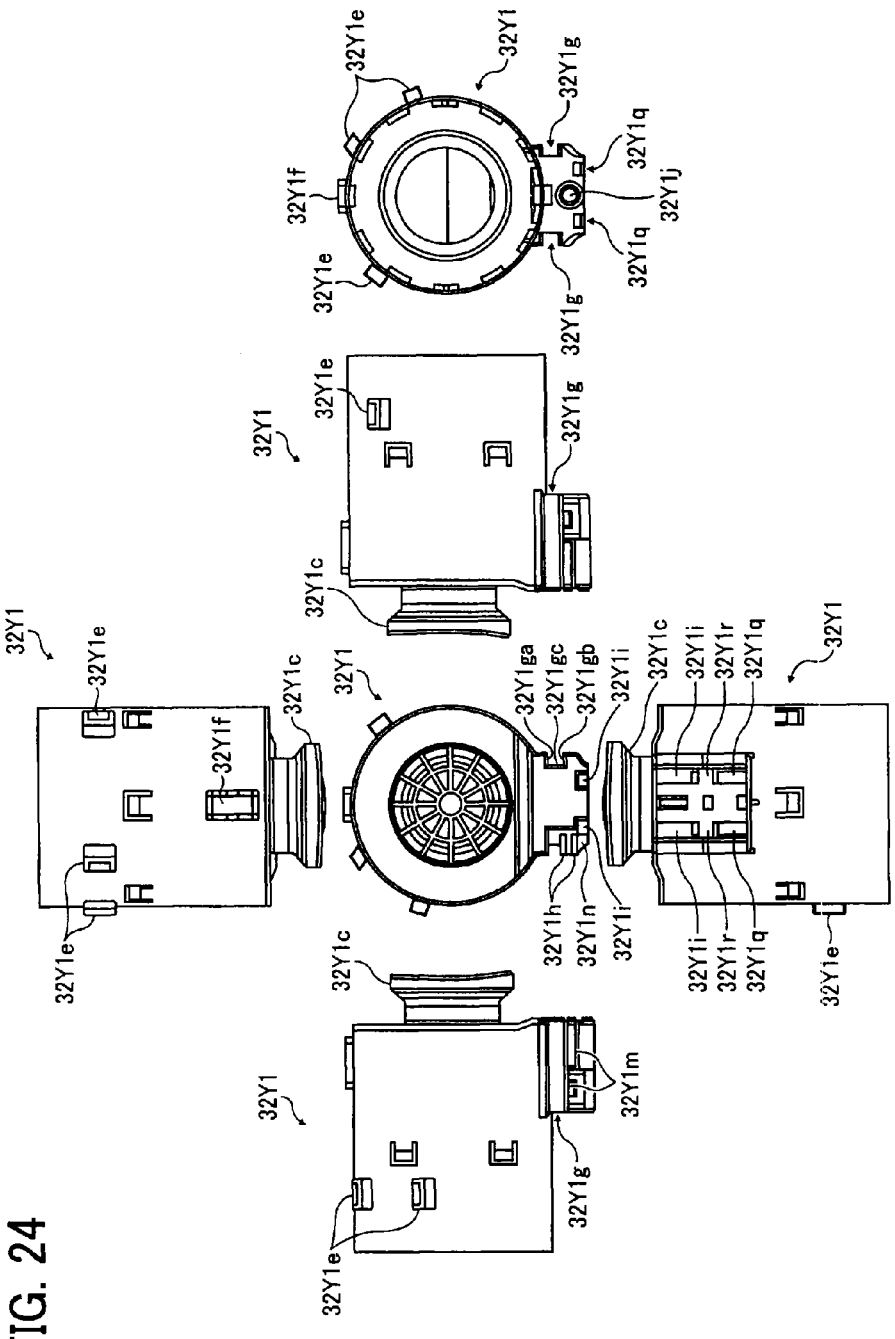

32Y1
32Y1e
32Y1f
32Y1g
32Y1q
32Y1j
32Y1c
32Y1ga
32Y1gc
32Y1gb
32Y1i
32Y1h
32Y1n
32Y1r
32Y1m

FIG. 24

FIG. 25

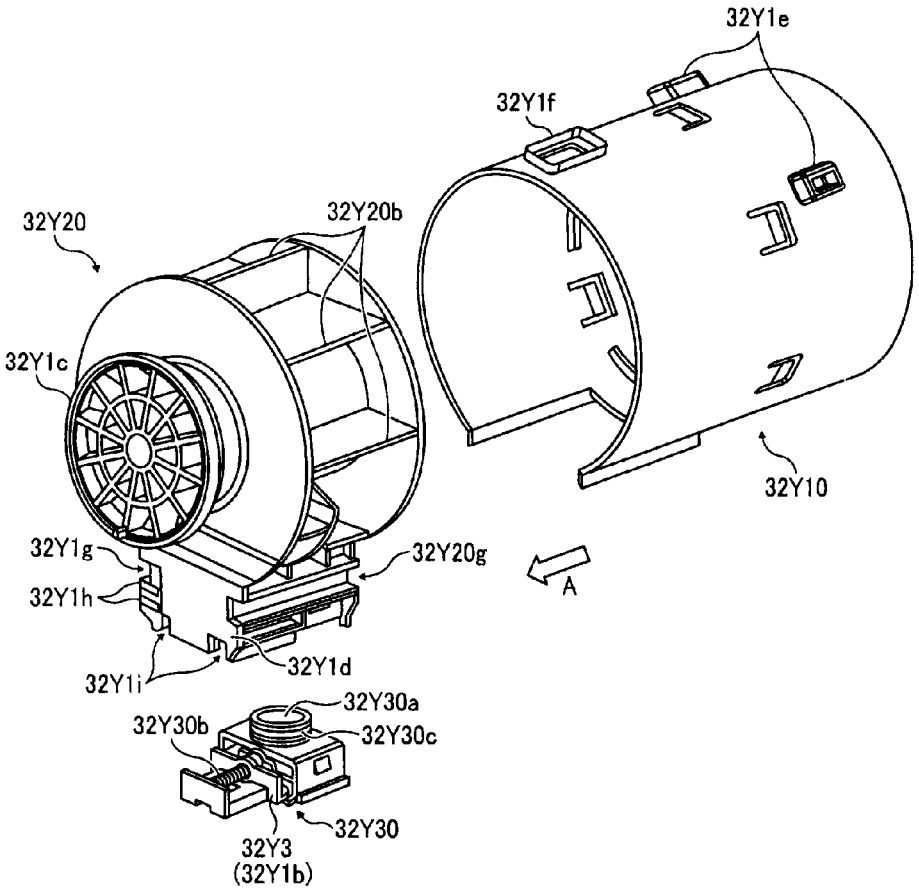
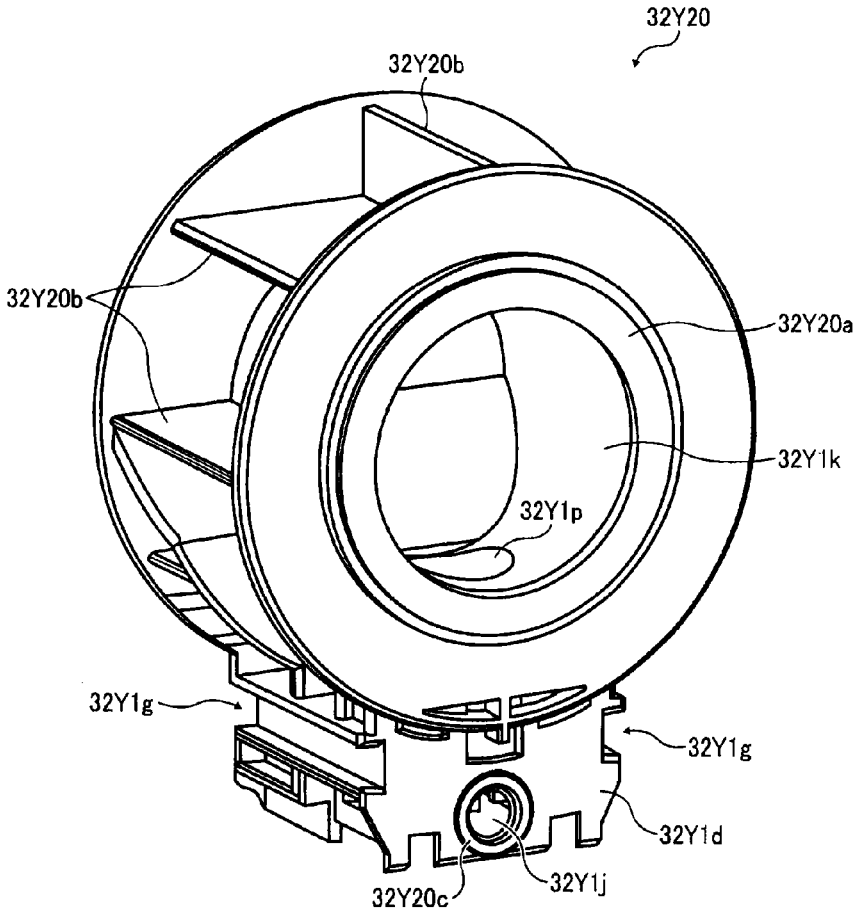

32Y1e
32Y1f
32Y20
32Y20b
32Y1c
32Y10
32Y1g
32Y20g
32Y1h
A
32Y1i
32Y1d
32Y30a
32Y30b
32Y30c
32Y30
32Y3
(32Y1b)

FIG. 26


32Y20
32Y20b
32Y20b
32Y20a
32Y1k
32Y1p
32Y1g
32Y1g
32Y1d
32Y1j
32Y20c

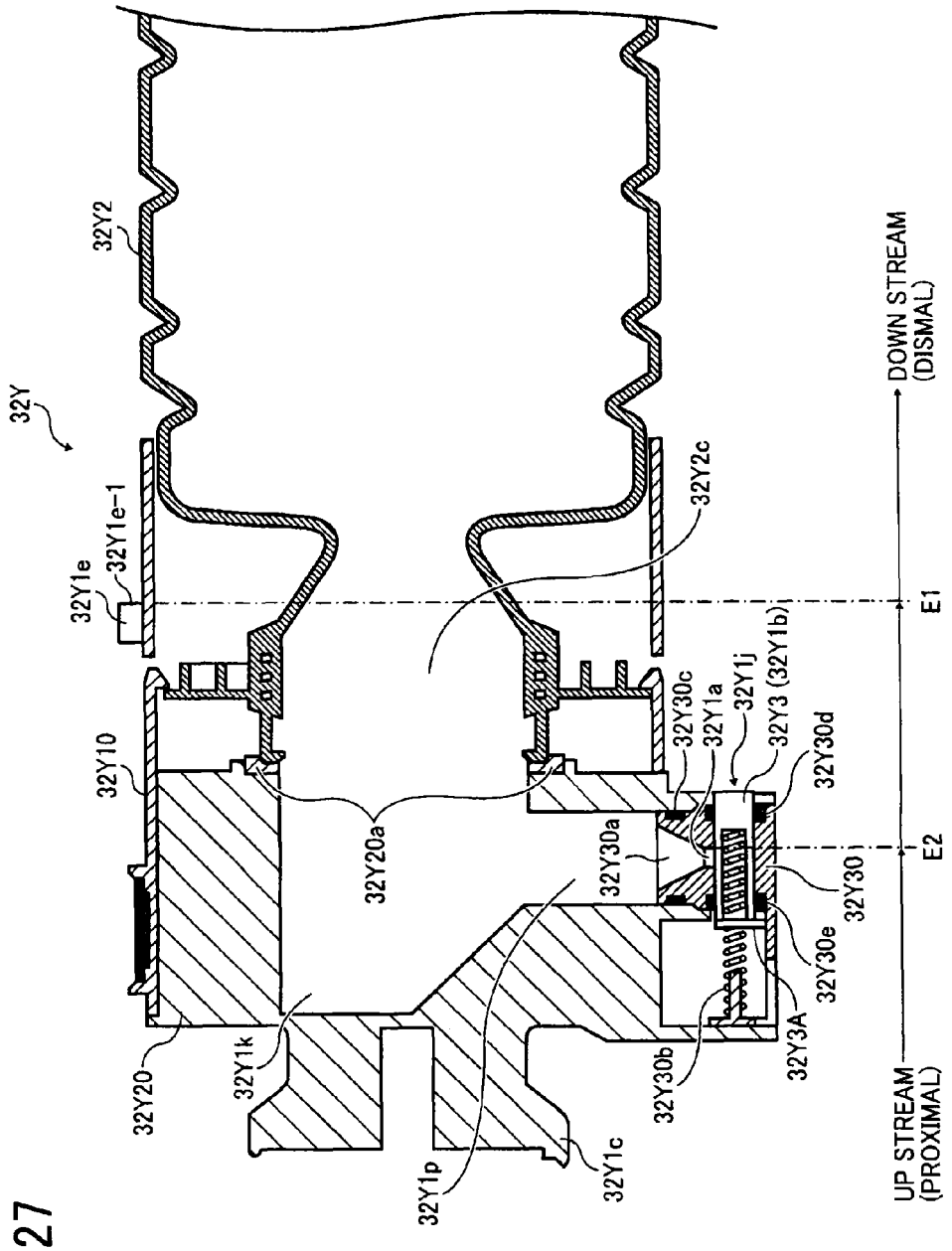

32Y
32Y2
32Y1e
32Y1e-1
32Y2c
32Y10
32Y20a
32Y30c
32Y1a
32Y1j
32Y3 (32Y1b)
32Y30d
32Y30a
32Y30
32Y30e
32Y3A
32Y30b
32Y20
32Y1k
32Y1p
32Y1c
E1
E2
DOWN STREAM
(DISMAL)
UP STREAM
(PROXIMAL)

FIG. 27

FIG. 28

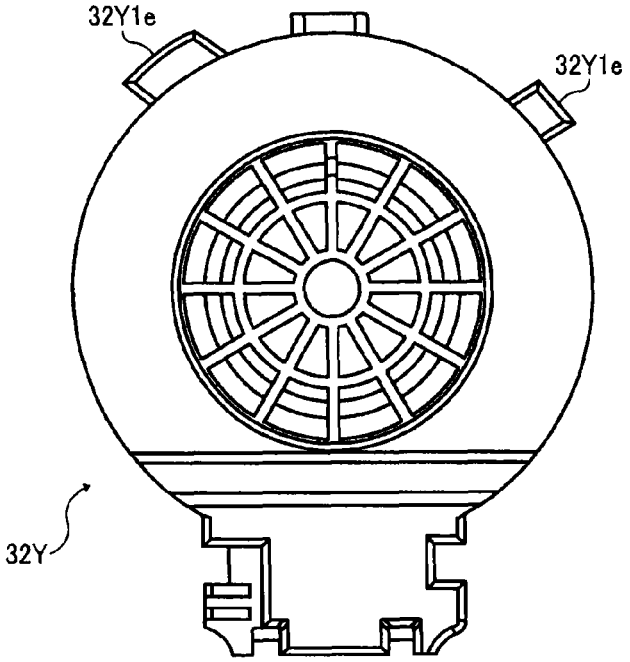


FIG. 29

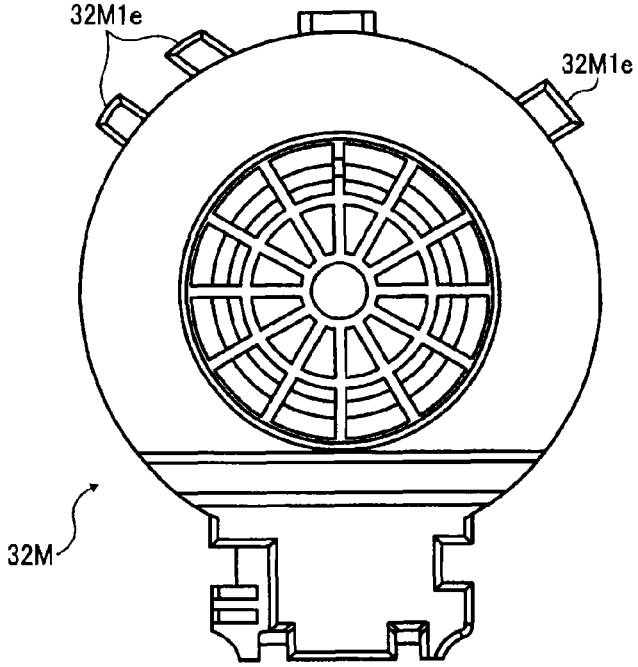


FIG. 30

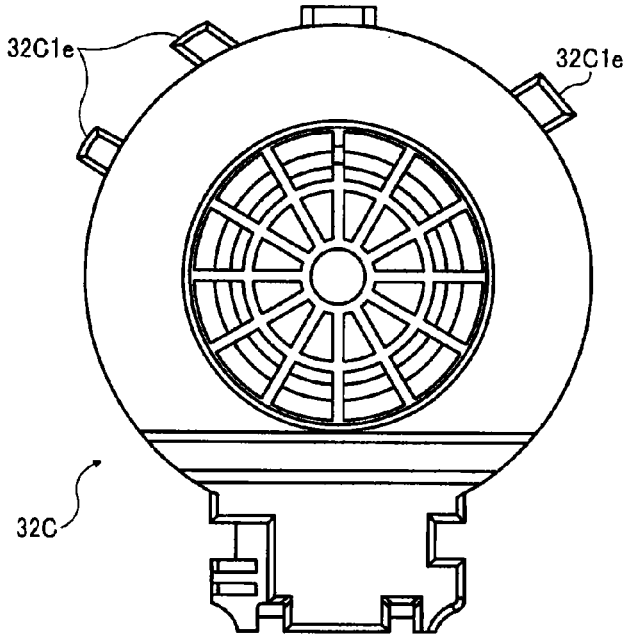
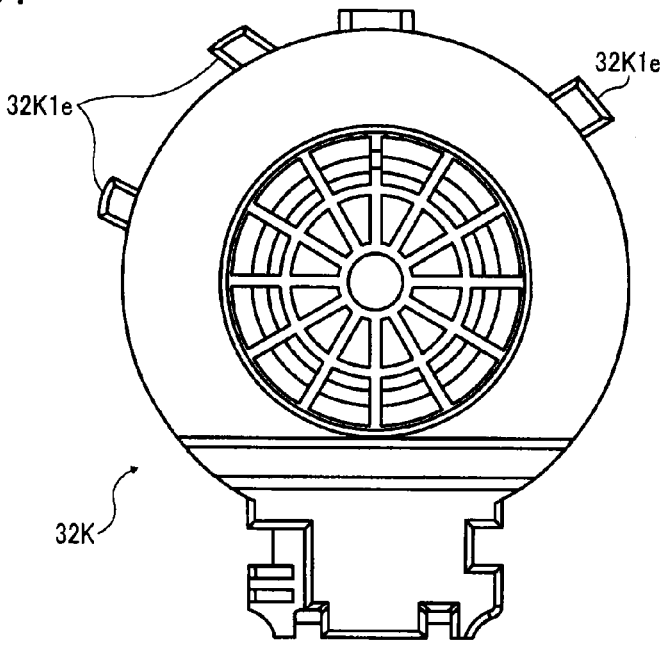


FIG. 31



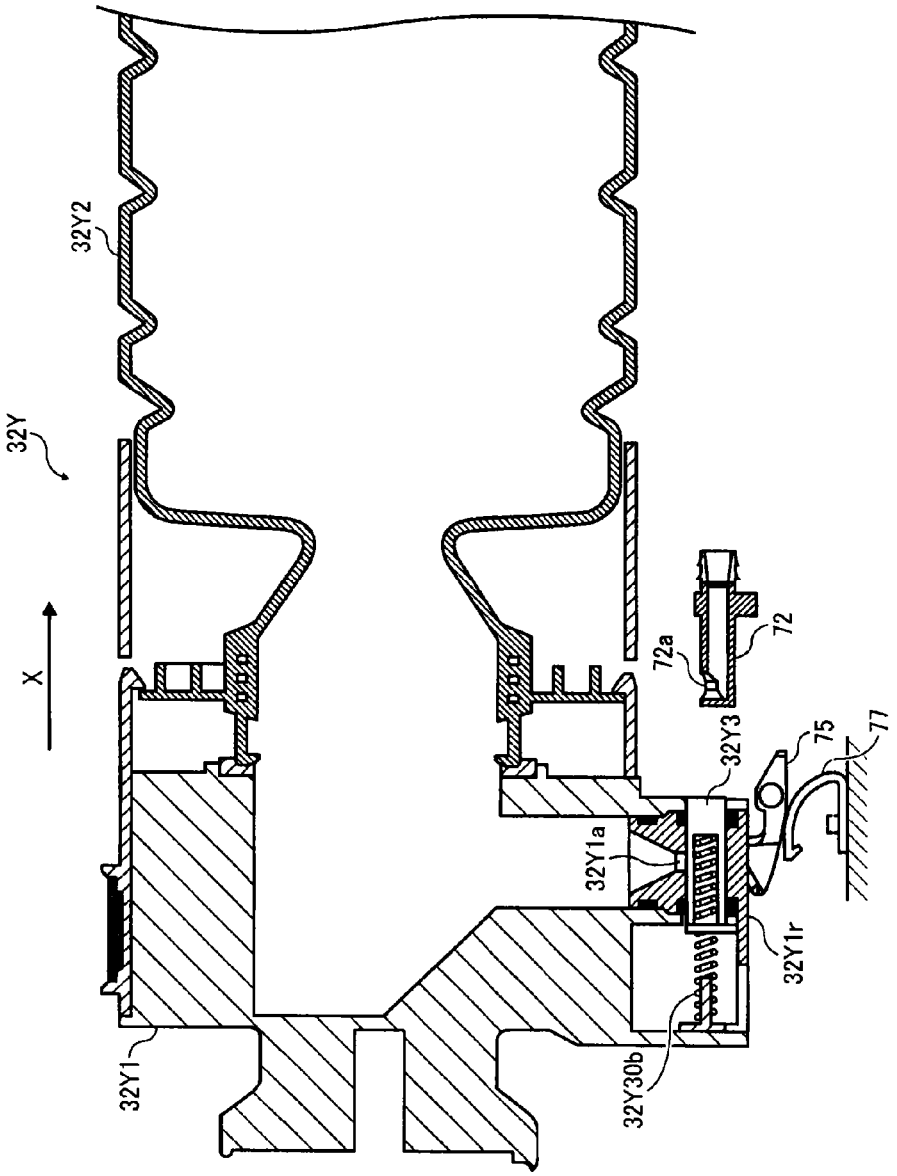


FIG. 32

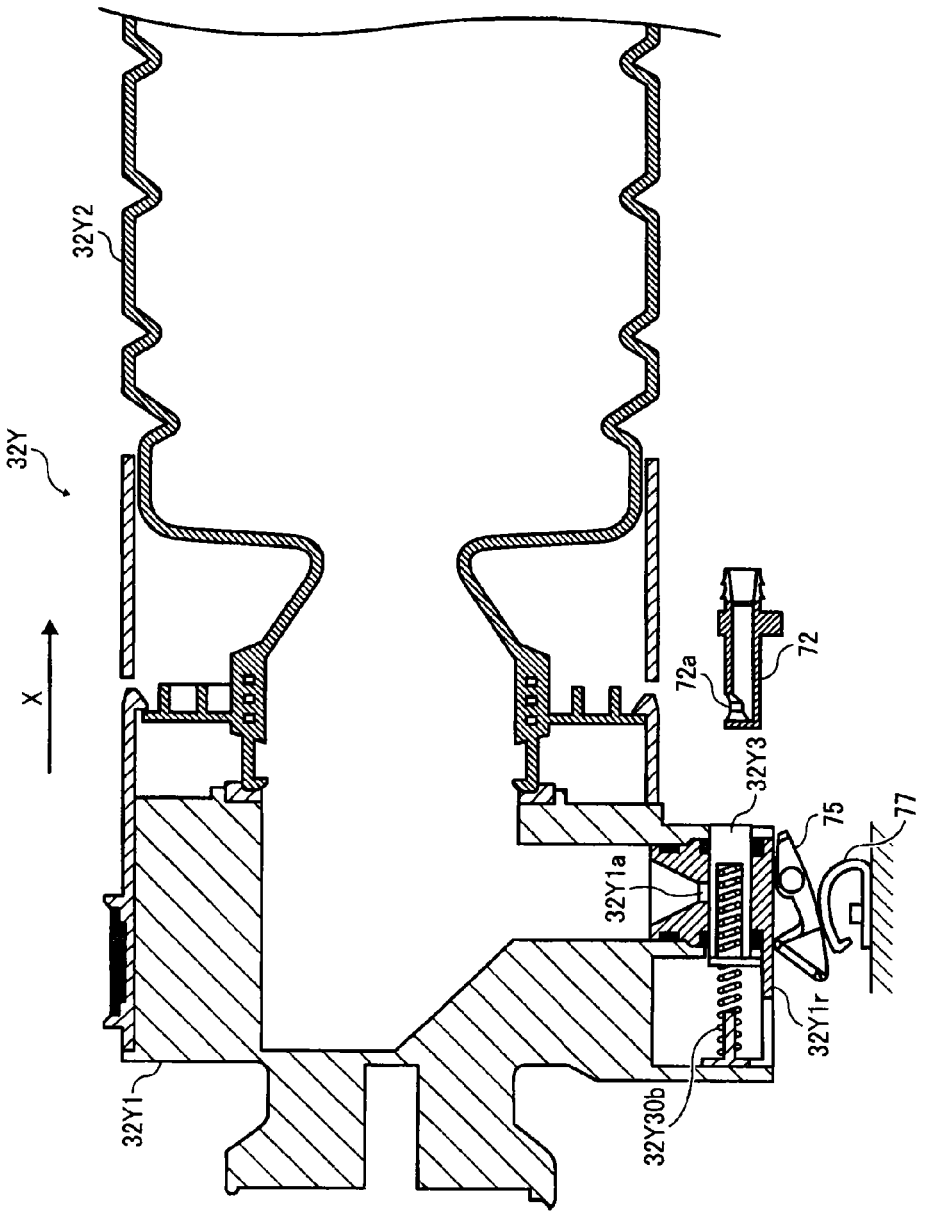


FIG. 33

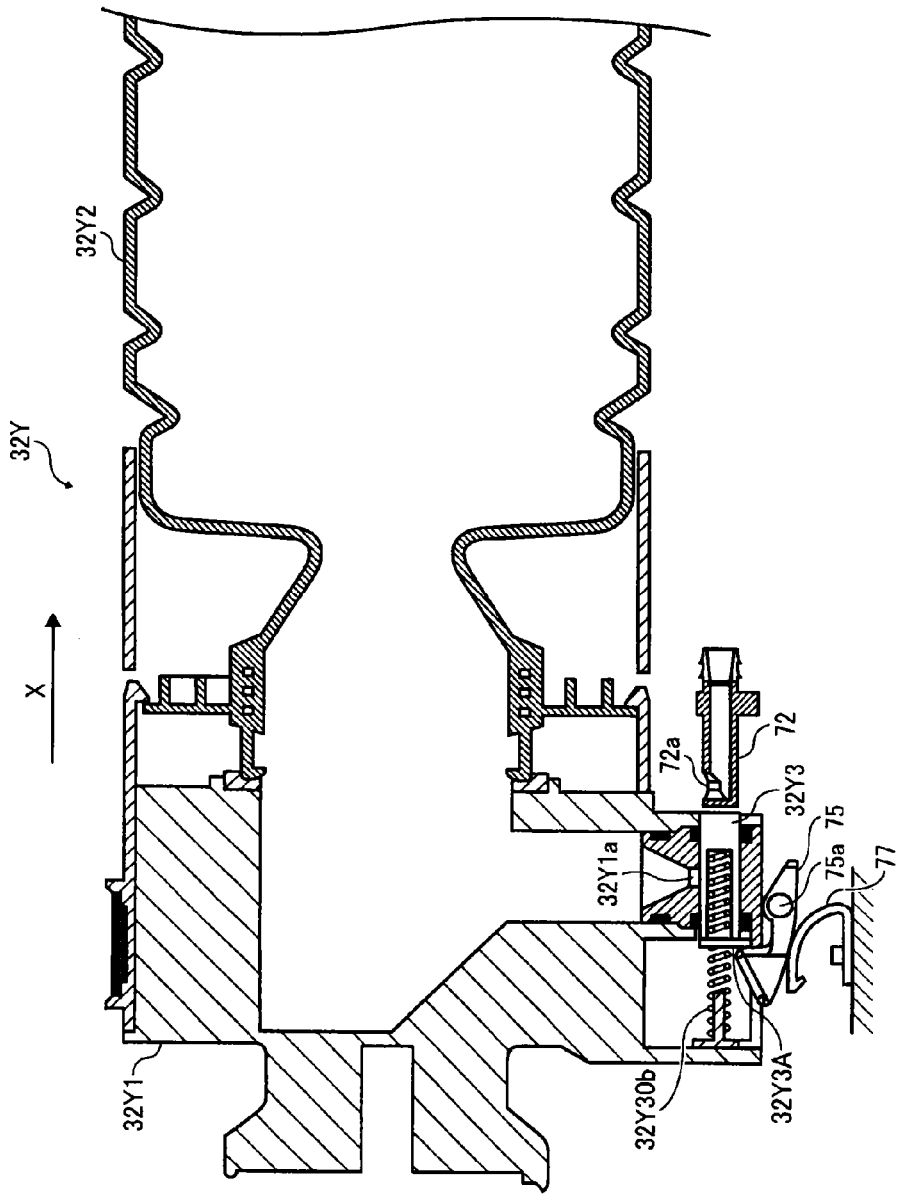


FIG. 34

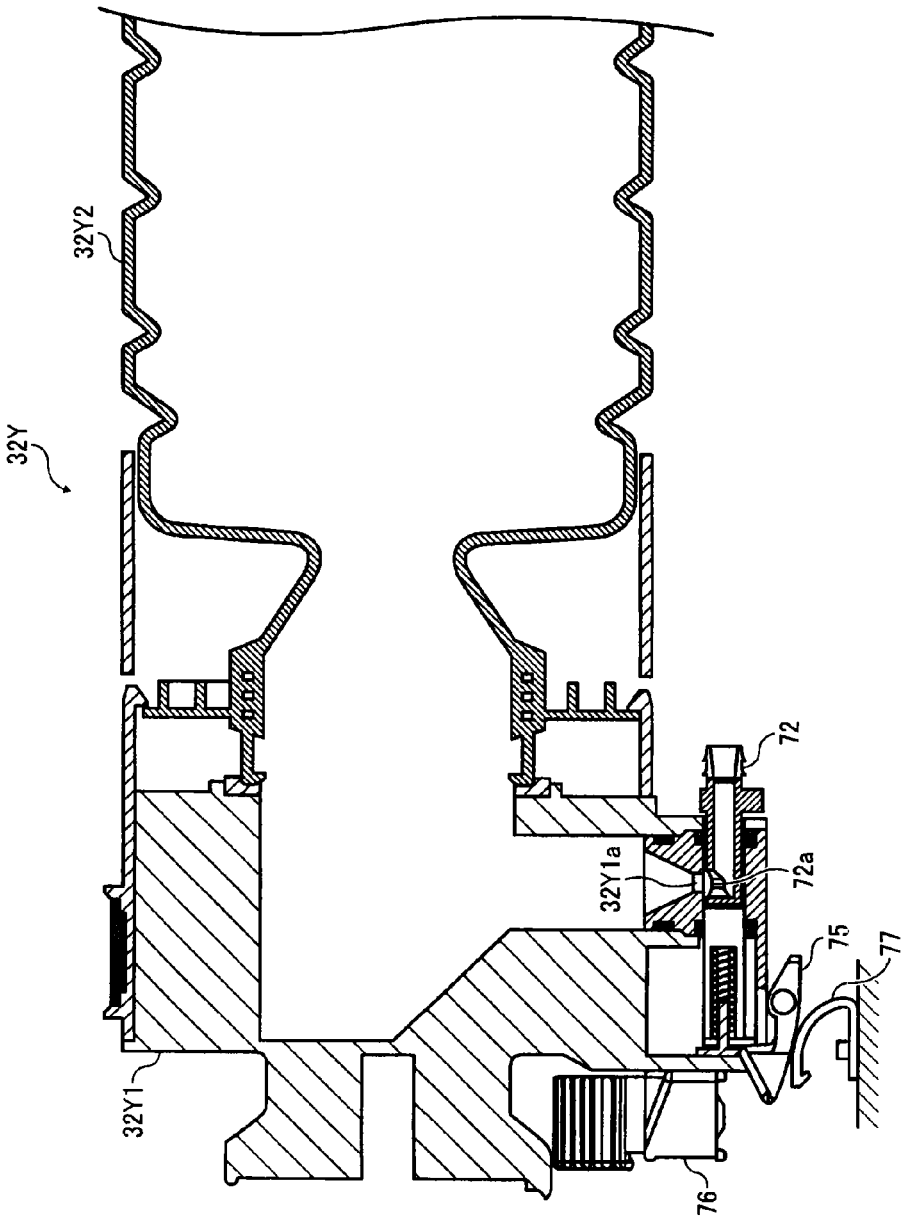


FIG. 35

FIG. 36

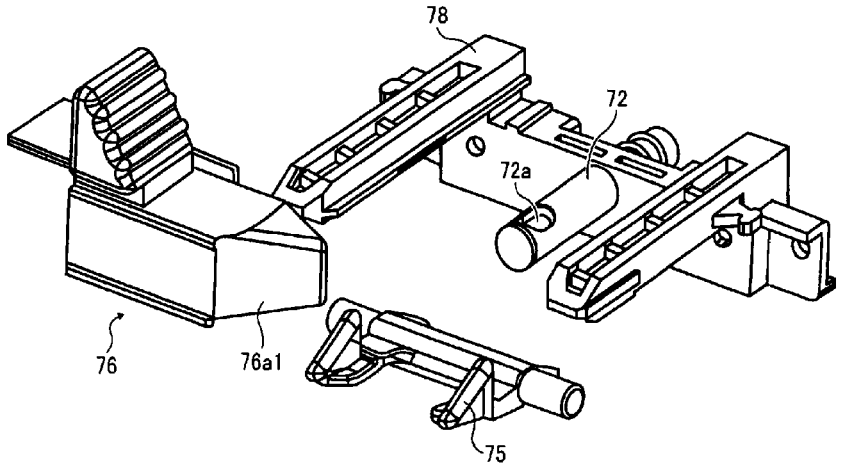


FIG. 37

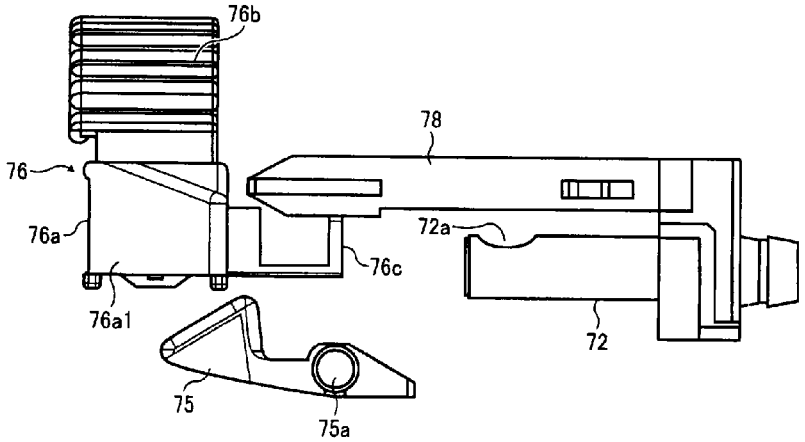


FIG. 38

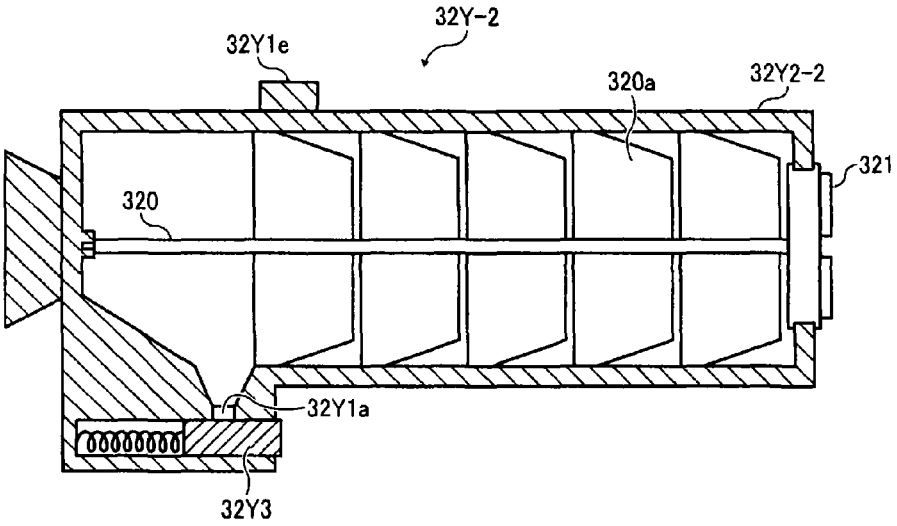

32Y-2
32Y1e
320a
32Y2-2
321
320
32Y1a
32Y3

FIG. 39

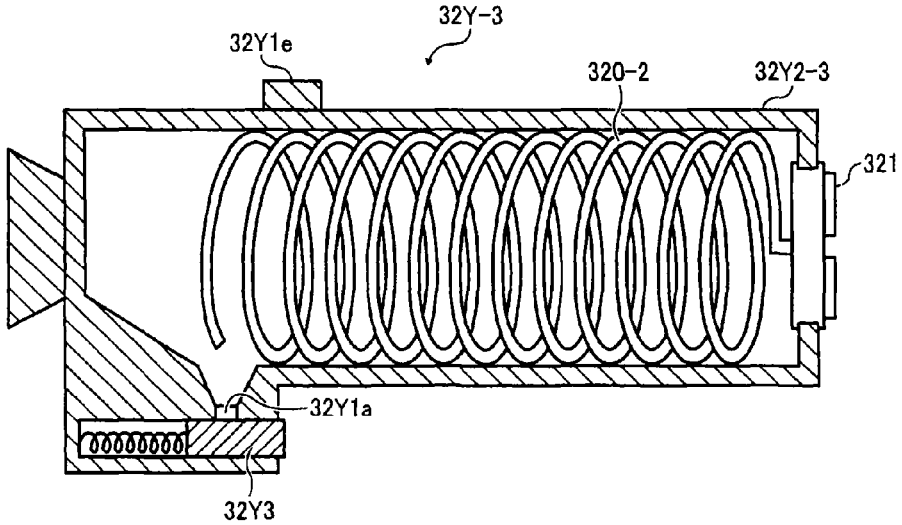

32Y-3
32Y1e
320-2
32Y2-3
321
32Y1a
32Y3

FIG. 40A

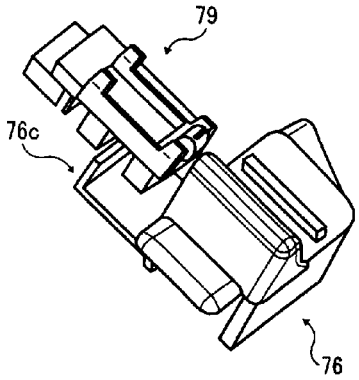


FIG. 40B

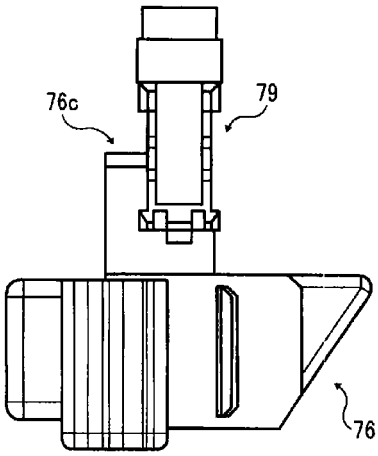


FIG. 40C

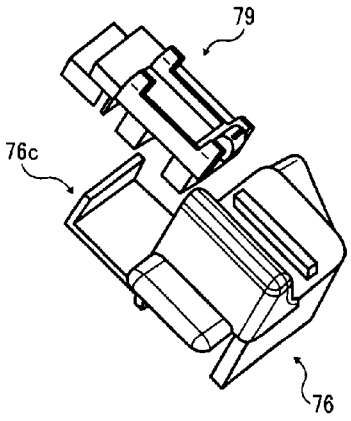


FIG. 40D

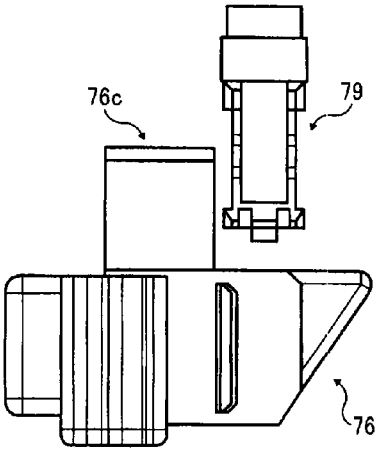


FIG. 41A

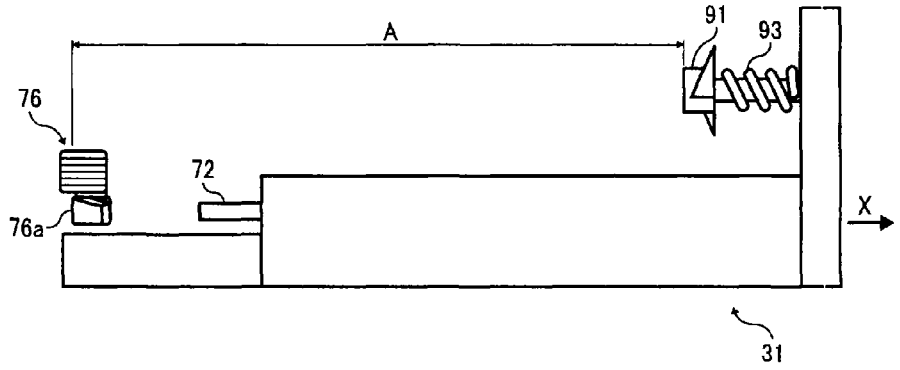


FIG. 41B

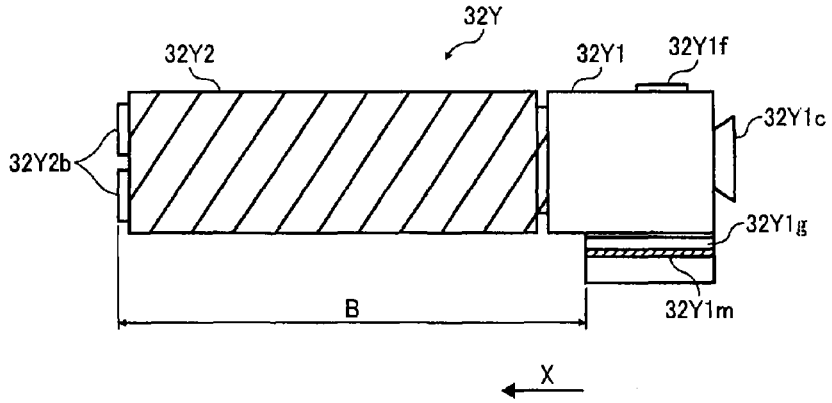


FIG. 42A

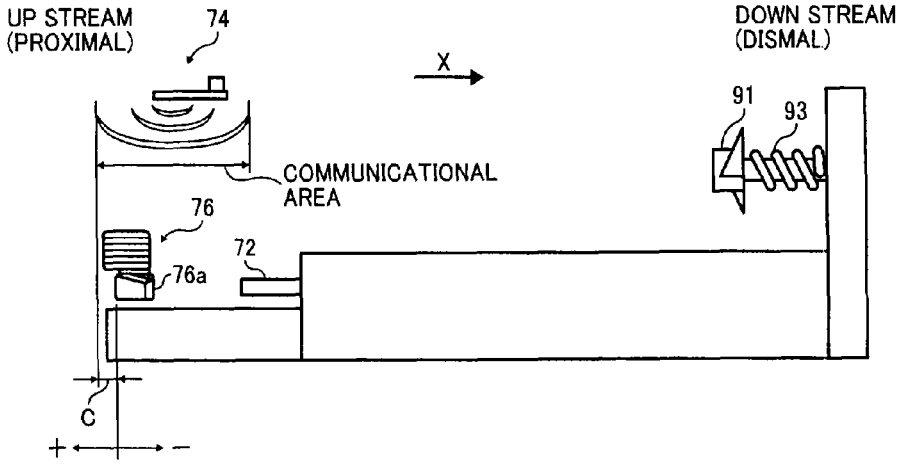


FIG. 42B

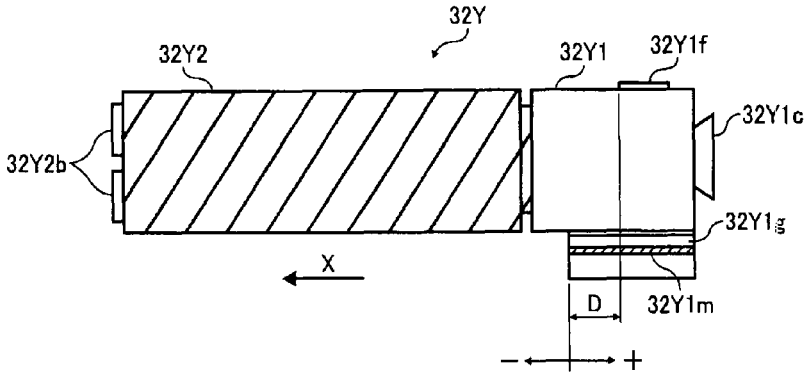
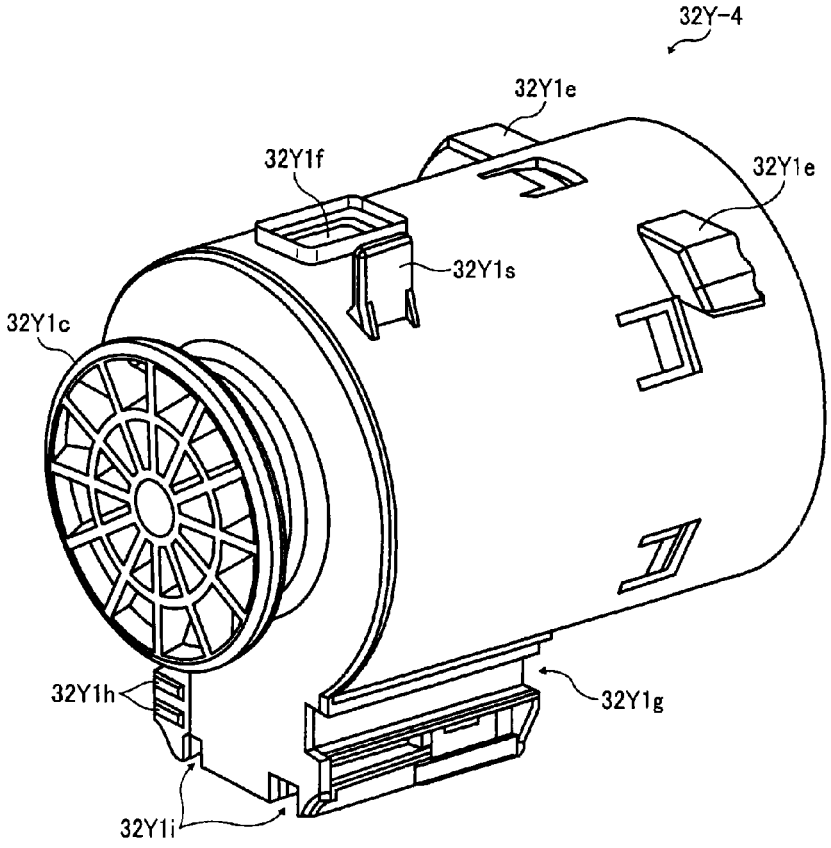


FIG. 43



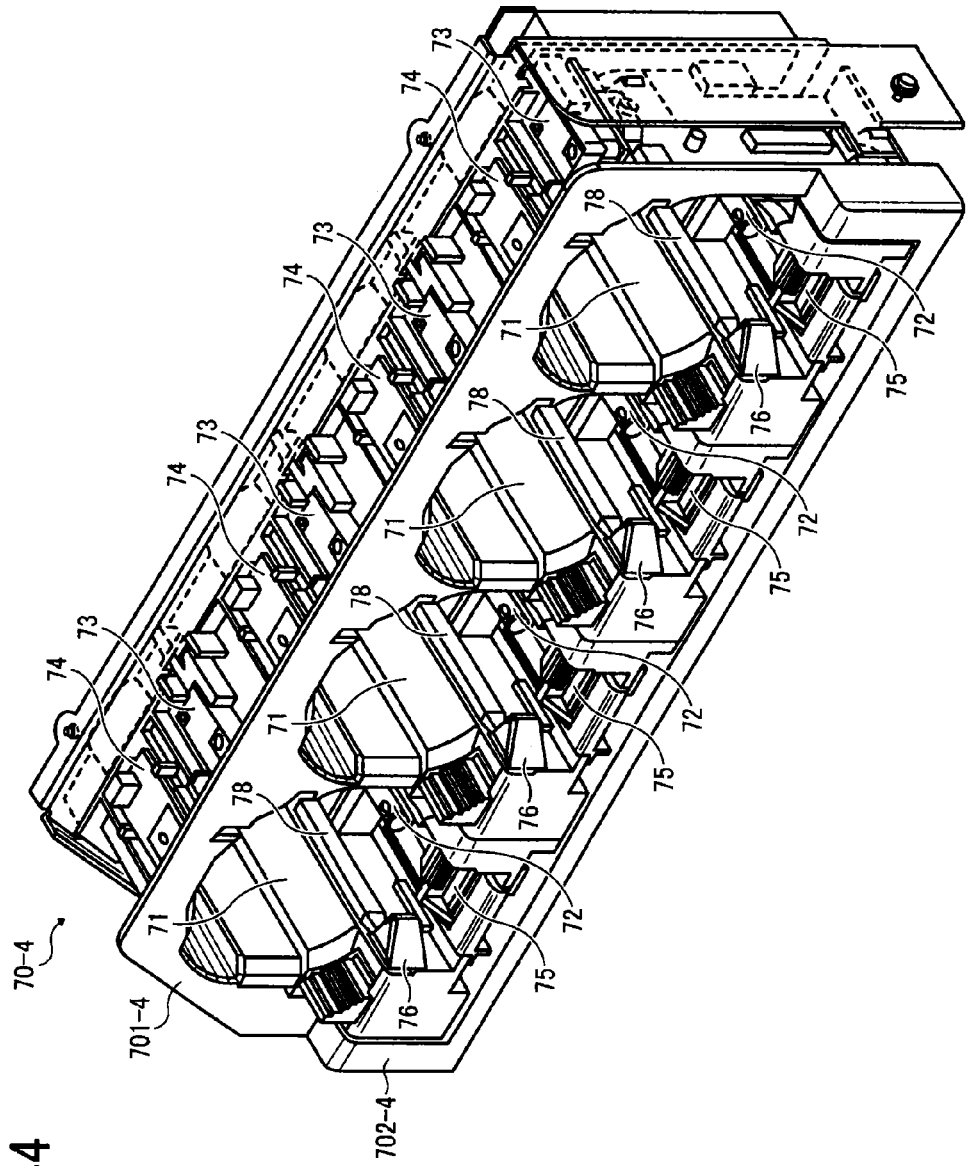


FIG. 44

FIG. 45

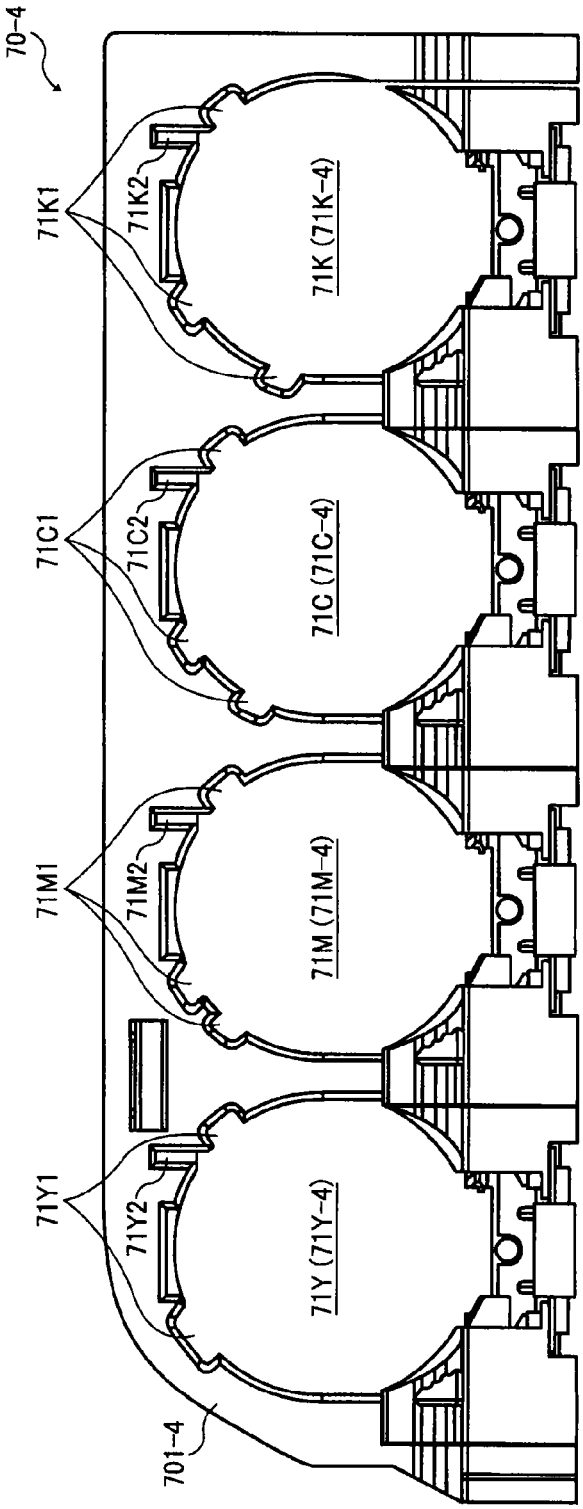

70-4
71K1
71K2
71K (71K-4)
71C1
71C2
71C (71C-4)
71M1
71M2
71M (71M-4)
71Y1
71Y2
71Y (71Y-4)
701-4

FIG. 46A

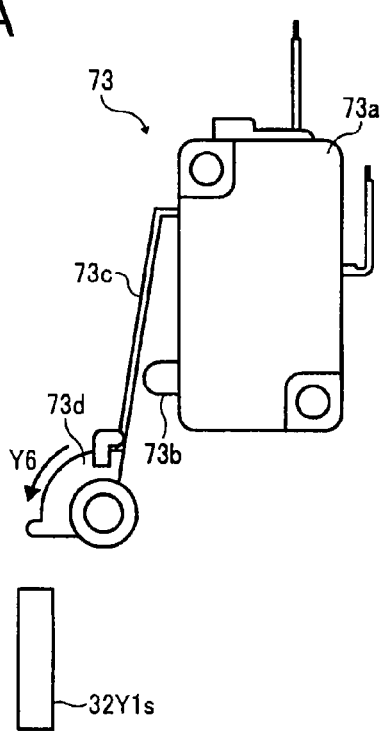


FIG. 46B

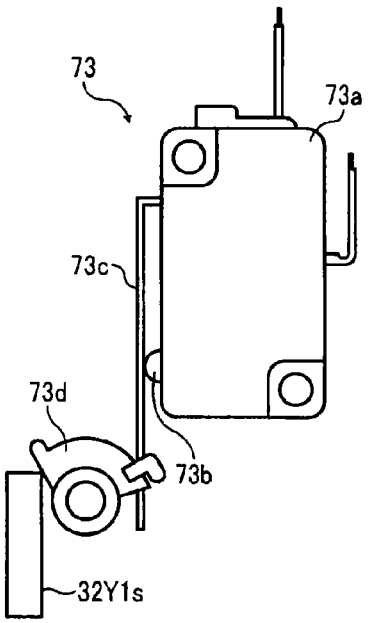


FIG. 47A

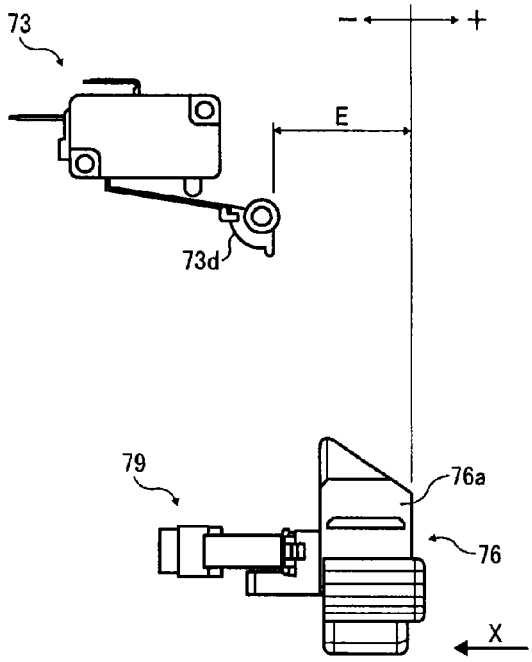


FIG. 47B

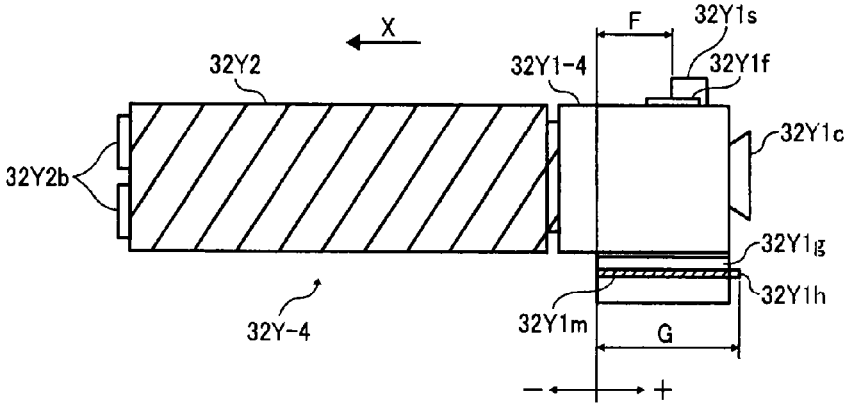


FIG. 48

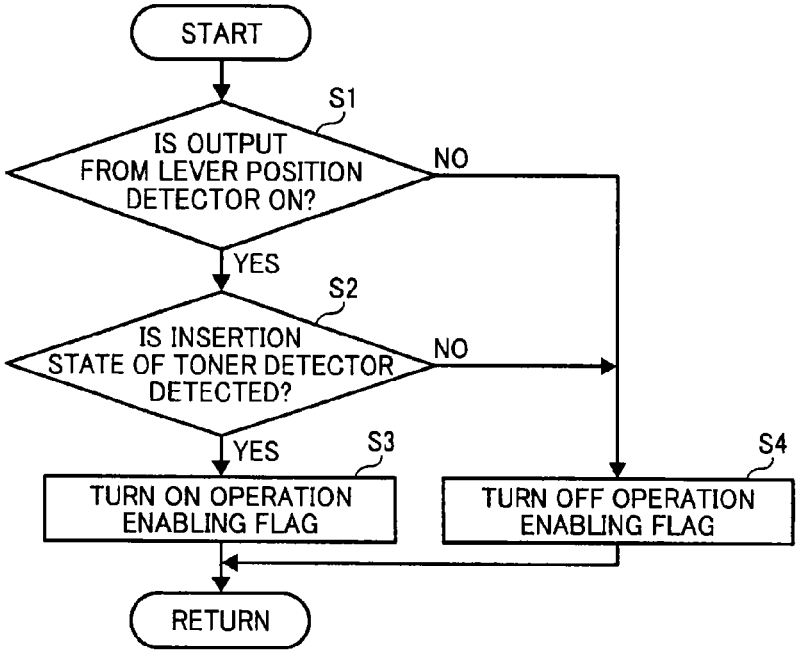

START
S1
IS OUTPUT FROM LEVER POSITION DETECTOR ON?
NO
YES
S2
IS INSERTION STATE OF TONER DETECTOR DETECTED?
NO
YES
S3
TURN ON OPERATION ENABLING FLAG
S4
TURN OFF OPERATION ENABLING FLAG
RETURN

FIG. 49

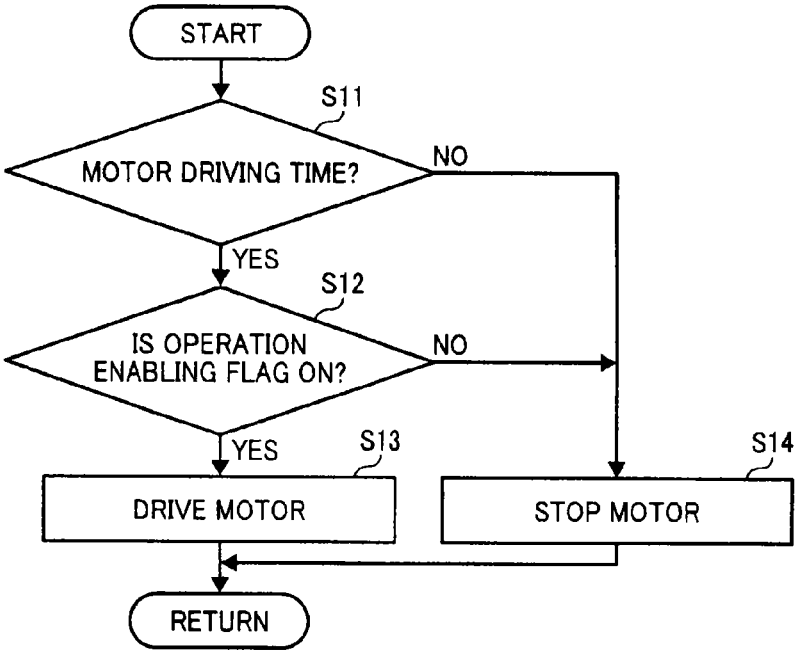

START
S11
MOTOR DRIVING TIME?
NO
YES
S12
IS OPERATION ENABLING FLAG ON?
NO
YES
S13
DRIVE MOTOR
S14
STOP MOTOR
RETURN

FIG. 50

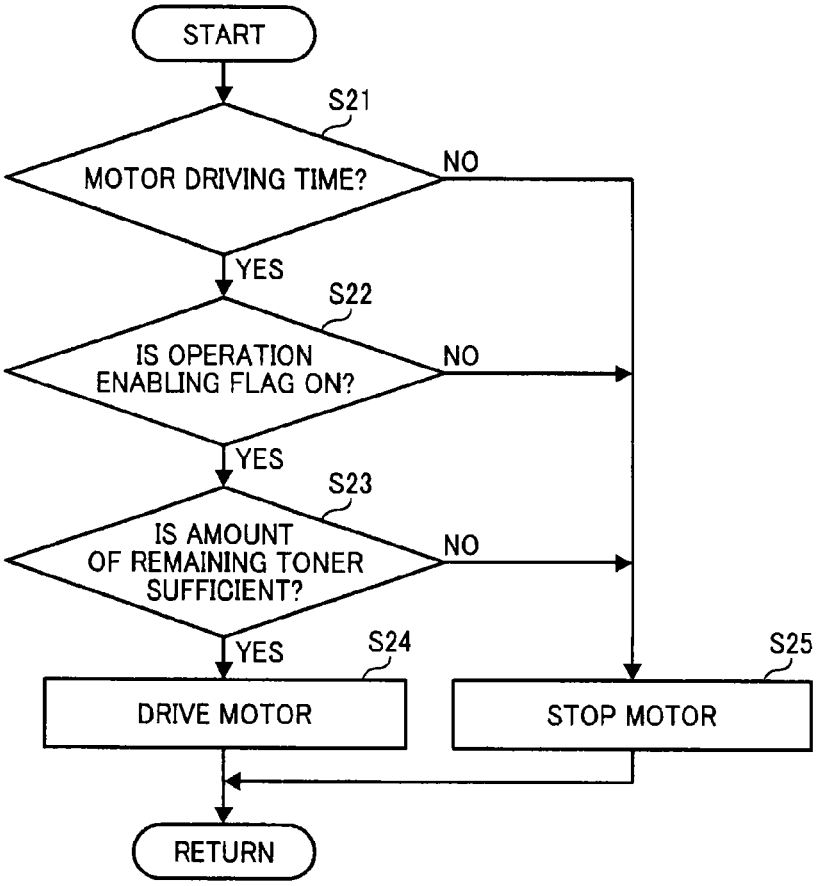
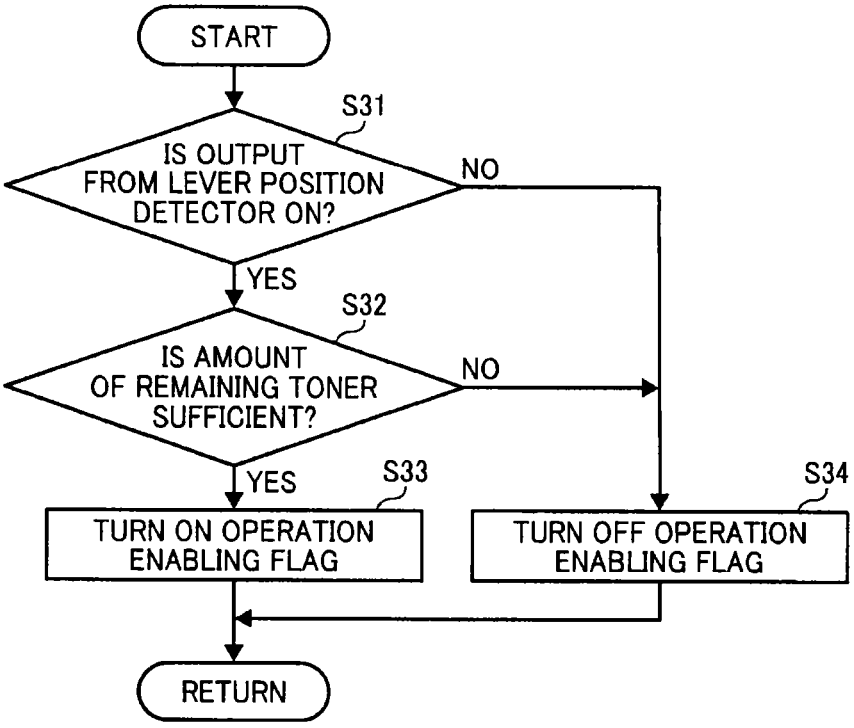

START
S21
MOTOR DRIVING TIME?
NO
YES
S22
IS OPERATION ENABLING FLAG ON?
NO
YES
S23
IS AMOUNT OF REMAINING TONER SUFFICIENT?
NO
YES
S24
DRIVE MOTOR
S25
STOP MOTOR
RETURN

FIG. 51


START
S31
IS OUTPUT FROM LEVER POSITION DETECTOR ON?
NO
YES
S32
IS AMOUNT OF REMAINING TONER SUFFICIENT?
NO
YES
S33
TURN ON OPERATION ENABLING FLAG
S34
TURN OFF OPERATION ENABLING FLAG
RETURN

POWDER CONTAINER, POWDER SUPPLY ASSEMBLY, AND IMAGE FORMING APPARATUS IN WHICH A POWDER OUTLET FACES IN AN OPPOSITE DIRECTION AS AN OPENING OF A CONTAINER BODY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a divisional application of U.S. application Ser. No. 13/075,641, filed Mar. 30, 2011, which is based on and claims priority from Japanese Patent Application Nos. 2010-085101, filed on Apr. 1, 2010, and 2010-152823, filed on Jul. 5, 2010 in the Japan Patent Office. The entire contents of each of the above are herein incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a powder container for containing powder such as toner and an image forming apparatus such as a copier, a printer, a facsimile machine, a plotter, or a multifunction machine capable of at least two of these functions that includes the powder container.

2. Description of the Background Art

In general, electrophotographic image forming apparatuses such as copiers, printers, facsimile machines, or multifunction machines including at least two of these functions include a development device to develop latent images formed on an image carrier. In addition, cylindrical toner containers (bottles) for containing toner, removably installable in main bodies of image forming apparatuses, are widely used.

For example, JP-2004-287404-A proposes a toner bottle that includes a bottle body having an opening on one side, a cap to cover the opening of the bottle body, and a spiral protrusion formed in an inner circumferential surface of the bottle body. As the bottle body rotates, the toner contained in the bottle body is transported along the spiral protrusion to the opening of the bottle body. The cap is retained in the main body in such a way as not to rotate as the bottle body rotates. The toner discharged from the bottle body is discharged outside the toner bottle through a toner outlet formed in the cap and supplied to a development device. The toner outlet is formed on the bottom of the cap so that the toner flows down under its own weight.

The cap includes a shutter to open and close the toner outlet. The shutter opens and closes the toner outlet in conjunction with installation of the toner bottle in the image forming apparatus.

The toner bottle proposed in the JP-2004-287404-A can alleviate leakage of toner in replacement of the toner bottle compared with the toner bottle without the cap because users need not touch the toner outlet owing to the shutter.

Additionally, in JP-2006-058698-A, the cap of the toner bottle includes a nozzle insertion portion into which a nozzle provided in the main body of the image forming apparatus is inserted. The shutter of the toner outlet blocks the nozzle insertion portion when the toner bottle is not installed in the image forming apparatus, to prevent leakage of toner.

Additionally, JP-2008-233667 proposes a toner container in which the shutter to close the toner outlet is movable horizontally, which is identical to a direction in which the toner container is slidingly installed in the apparatus.

Those toner containers typically include discrimination protrusions projecting from outer circumferential surfaces of the toner containers. The shape or arrangement of the discrimination protrusions is unique to each color of toner, and insertion openings formed in the image forming apparatus have a shape that fits only the discrimination protrusion of the toner container for the corresponding color. Such an arrangement ensures that a toner container of the wrong color is prevented from being inserted set in a container mount for specific color in the apparatus.

In particular, in the arrangement in which the toner container is horizontally inserted in the image forming apparatus as in JP-2008-233667, it is important to prevent the toner container of wrong color from being set in the container mount. However, when the toner container of wrong color is inserted, depending on the arrangement of the discrimination protrusions, it is possible that opening the toner outlet of the toner container is already started by the time the discrimination protrusion hits the insertion opening.

Moreover, in JP-2008-233667-A, when the toner container of the wrong color is inserted, it is possible that the shutter jolts due to some reason, thus opening the toner outlet unintentionally, because the direction in which the shutter moves parallels the installation direction of the toner container. As a result, the toner of the wrong color leaks out and onto the container mount.

SUMMARY OF THE INVENTION

In view of the foregoing, an object of this specification is to prevent powder container of a wrong type from being set in a power container mount of an apparatus.

An another object of this specification is to prevent leakage of the power therefrom when a user mistakenly tries to install the powder container of the wrong type in the power container mount of the apparatus.

In one illustrative embodiment of the present invention provides a powder container, removably installable horizontally in an apparatus. The apparatus includes a horizontally extending tube connectable to the powder container.

The powder container includes a powder containing compartment for containing a powder, extending horizontally, and, having a powder outlet connectable to a powder inlet of the tube of the apparatus in conjunction with installation of the powder container in the apparatus, a removably insertable plug member to open and close the powder outlet of the powder containing compartment in conjunction with installation of the powder container in the apparatus, and a discrimination portion including at least one discrimination protrusion projecting from an outer circumferential surface of the powder container. The powder contained in the powder containing compartment is discharged from the powder outlet thereof to the tube via the powder inlet of the tube. The discrimination portion is positioned with a downstream end of the discrimination protrusion downstream from a downstream end of the powder outlet of the powder containing compartment in an installation direction in which the powder container is installed in the apparatus and, at least one of shape, arrangement, and quantity of the protrusion is unique to the type of powder contained in the powder container.

Another illustrative embodiment provides an image forming apparatus that includes the above-described powder container.

Yet another illustrative embodiment provides a powder supply assembly to supply a powder to an apparatus.

The powder supply assembly includes a powder container for containing the powder, having a powder outlet; a container

mount provided in the apparatus, in which the powder container is removably installed, a container driving unit to rotate the powder container at least partially to discharge the powder from the powder container through the powder outlet, a container detector to detect whether the powder container is set at the installation position in the container mount, a retainer movable between a retaining position to retain the powder container at an installation position in the container mount and a release position to unlock the powder container from the installation position, a retainer detector to detect whether or not the retainer is at the retaining position, and a controller provided in the apparatus, operatively connected to the container detector as well as the retainer detector to permit or prohibit driving of the container driving unit based on a combination of a detection result generated by the container detector and a detection result generated by the retainer detector.

Yet another illustrative embodiment provides an image forming apparatus that includes the above-described powder supply assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the disclosure and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is a schematic diagram illustrating a configuration of an image forming apparatus according to an illustrative embodiment of the present invention;

FIG. **2** is a schematic cross-sectional view illustrating a configuration of an image forming unit included in the image forming apparatus shown in FIG. **1**;

FIG. **3** is a schematic diagram that illustrates a toner supply device and a toner container;

FIG. **4** is a perspective view of a toner container mount;

FIG. **5** is a perspective view of a bottle driving unit;

FIG. **6** is a schematic diagram that illustrates an engagement process of the toner container between the bottle driving unit;

FIG. **7** is a schematic diagram that illustrates the toner container engaged with the bottle driving unit;

FIG. **8** is a perspective view of a bottle fixing portion;

FIG. **9** is a perspective view that illustrates a vicinity of a lower front case of the bottle fixing portion;

FIG. **10** is another perspective view that illustrates the vicinity of the lower front case;

FIG. **11** is a perspective view of a lever for fixing and releasing the toner container;

FIG. **12** is a front view that illustrates the lever when the toner container is installed in the toner container mount;

FIG. **13** is a front view that illustrates the lever when the toner container is being inserted into the toner container mount;

FIG. **14** is a schematic view that illustrates installation of the toner container into the toner container mount as viewed from the bottom of the toner container;

FIG. **15** is schematic view that illustrates a state subsequent to that shown in FIG. **14** in installation of the toner container as viewed from the bottom of the toner container;

FIG. **16** is schematic view that illustrates a state subsequent to that shown in FIG. **15** in installation of the toner container as viewed from the bottom of the toner container;

FIG. **17** is a schematic view that illustrates the toner container secured in the toner container mount as viewed from the bottom of the toner container;

FIG. **18** is a front view of insertion openings in which the respective toner containers are inserted;

FIG. **19** is a perspective view of the toner container;

FIG. **20** is a perspective view of the toner container as viewed from another angle;

FIG. **21** is a perspective view that illustrates an exterior of a container body of the toner container;

FIG. **22** is a perspective view that illustrates an exterior of a cap of the toner container;

FIG. **23** is another perspective view that illustrates the exterior of the cap;

FIG. **24** is a set of six sides views of the cap;

FIG. **25** is an exploded perspective view of the cap;

FIG. **26** is a perspective view of a handle body;

FIG. **27** is a cross-sectional view of a vicinity of the cap;

FIG. **28** is a front view of the cap of the yellow toner container;

FIG. **29** is a front view of the cap of the magenta toner container;

FIG. **30** is a front view of the cap of the cyan toner container;

FIG. **31** is a front view of the cap of the black toner container;

FIG. **32** is a schematic cross-sectional view that illustrates installation of the toner container into the toner container mount;

FIG. **33** is schematic cross-sectional view that illustrates a state subsequent to that shown in FIG. **32** in installation of the toner container;

FIG. **34** is schematic cross-sectional view that illustrates a state subsequent to that shown in FIG. **33** in installation of the toner container;

FIG. **35** is a cross-sectional view that illustrates the toner container set in the toner container mount;

FIG. **36** is a perspective view that illustrates relative positions of a nozzle, a pawl, and the lever for fixing and releasing the toner container;

FIG. **37** is a side view that illustrates the relative positions of the nozzle, the pawl, and the lever for fixing and releasing the toner container;

FIG. **38** is a schematic cross-sectional view of a toner container according to another embodiment;

FIG. **39** is a schematic cross-sectional view of another configuration of the toner container;

FIGS. **40**A and **40**B are a perspective view and a top view of the lever for fixing and releasing the toner container at a retaining position, respectively;

FIGS. **40**C and **40**D are a perspective view and a top view of the lever at a release position, respectively;

FIGS. **41**A and **41**B are schematic side views of the toner container and the toner container mount;

FIGS. **42**A and **42**B are schematic side views of the toner container and the toner container mount;

FIG. **43** is a perspective view of a cap of a toner container according to another illustrative embodiment;

FIG. **44** is a schematic perspective view of a bottle fixing portion according to another illustrative embodiment;

FIG. **45** is a schematic front view of the bottle fixing portion shown in FIG. **44**;

FIGS. **46**A and **46**B are top views of an interlock switch;

FIGS. **47**A and **47**B are respectively a schematic side view and a top view that illustrate the toner container, the interlock switch, and the lever;

FIG. **48** is a flowchart that illustrates a sequence of processes for setting operation enabling flag by a controller of the image forming apparatus according to an illustrative embodiment;

FIG. **49** is a flowchart that illustrates a sequence of processes for allowing or forbidding rotation of the toner container by the controller;

FIG. **50** is a flowchart that illustrates processes for allowing and forbidding driving of a screw pump by the controller; and

FIG. **51** is a flowchart that illustrates a flow of processes for setting operation enabling flag according to another embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In describing preferred embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this patent specification is not intended to be limited to the specific terminology so selected, and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner and achieve a similar result.

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views thereof, and particularly to FIGS. **1** and **2**, an electrophotographic image forming apparatus according to an illustrative embodiment of the present invention is described. It is to be noted that the subscripts Y, M, C, and K attached to the end of each reference numeral indicate only that components indicated thereby are used for forming yellow, magenta, cyan, and black images, respectively, and hereinafter may be omitted when color discrimination is not necessary.

(First Embodiment)

A configuration and operation of an image forming apparatus according to a first embodiment is described below with reference to FIGS. **1** and **2**.

As shown in FIG. **1**, an image forming apparatus **200** includes a toner container mount **31**, serving as a powder container mount, provided above a main body **100** of the image forming apparatus **200**. Four toner containers **32**Y, **32**M, **32**C, and **32**K (shown in FIG. **3**) for containing yellow, magenta, cyan, and black toners, respectively, are removably installed in the toner container mount **31**. That is, the toner containers **32**Y, **32**M, **32**C, and **32**K are replaceable.

The image forming apparatus **200** according to the present embodiment includes four image forming units **3**Y, **3**M, **3**C, and **3**K for forming yellow, magenta, cyan, and black toner images, respectively. Each of the image forming units **3**Y, **3**M, **3**C, and **3**K are removably installable in the main body **100**.

Although not shown in FIG. **1**, toner supply devices **60**Y, **60**M, **60**C, and **60**K shown in FIG. **3** are provided above the image forming units **3**Y, **3**M, **3**C, and **3**K.

Each toner supply device **60** supplies the toner contained in the corresponding toner container **32** to a development device **5** of the corresponding image forming unit **3**.

Referring to FIG. **2**, the image forming unit **3**Y for yellow includes a photoreceptor drum **1**Y and further includes a charging member **4**Y, the development device **5**Y, a cleaning unit **2**Y, a discharger, and the like provided around the photoconductor drum **1**Y. Image forming processes, namely, charging, exposure, development, transfer, and cleaning processes are performed on the photoreceptor drum **1**Y, and thus a yellow toner image is formed on the photoreceptor drum **1**Y.

It is to be noted that other image forming units **3** have a similar configuration to that of the yellow image forming unit **3**Y except the color of the toner used therein and form toner images of the respective colors. Thus, only the image forming unit **3**Y is described below and descriptions of other image forming units are omitted.

Referring to FIG. **2**, the photoreceptor drum **1**Y is rotated counterclockwise in FIG. **2** by a driving motor (not shown). A surface of the photoreceptor drum **1**Y is charged uniformly at a position facing the charging member **4**Y by the charging member **4**Y (charging process).

When the photoreceptor drum **1**Y reaches a portion to receive a laser beam L emitted from an exposure unit **7** (shown in FIG. **1**), the photoreceptor drum **1**Y is scanned with the laser beam L, and thus an electrostatic latent image for yellow is formed thereon (exposure process).

Then, the photoreceptor drum **1**Y reaches a portion facing the development device **5**Y, where the latent image is developed with toner into a yellow toner image (development process).

When the surface of the photoreceptor drum **1**Y carrying the toner image reaches a portion facing the primary-transfer bias roller **9**Y via the intermediate transfer belt **8**, the toner image is transferred therefrom onto the intermediate transfer belt **8** (primary-transfer process). After the primary-transfer process, a certain amount of toner tends to remain on the photoreceptor drum **1**Y.

When the surface of the photoreceptor drum **1**Y reaches a position facing the cleaning unit **2**Y, a cleaning blade **2***a* of the cleaning unit **2**Y mechanically collects any toner remaining on the photoreceptor drum **1**Y (cleaning process).

Subsequently, the discharger removes potentials remaining on the surface of the photoreceptor drum **1**Y.

Thus, a sequence of image forming processes performed on the photoreceptor drum **1**Y is completed.

The above-described image forming processes are performed in the image forming units **3**M, **3**C, and **3**K similarly to the yellow image forming unit **3**Y. That is, the exposure unit **7** disposed above the image forming units **3** in FIG. **1** directs laser beams L according to image data onto the photoreceptor drums **1** in the respective image forming units **3**. Specifically, the exposure unit **7** includes light sources to emit the laser beams L, multiple optical elements, and a polygon mirror that is rotated by a motor. The exposure unit **7** directs the laser beams L to the respective photoreceptor drums **1** via the multiple optical elements while deflecting the laser beams L with the polygon mirror.

Then, the toner images formed on the respective photoreceptor drums **1** through the development process are transferred therefrom and superimposed one on another on the intermediate transfer belt **8**. Thus, a multicolor toner image is formed on the intermediate transfer belt **8**.

Referring now to FIG. **1**, the intermediate transfer unit **6** includes the intermediate transfer belt **8**, the four primary-transfer bias rollers **9**, a secondary-transfer backup roller **10**, multiple tension rollers, and a belt cleaning unit. The intermediate transfer belt **8** is supported by the multiple rollers and is rotated in the direction indicated by an arrow shown in FIG. **1** as one of the multiple rollers that serves as a driving roller rotates.

The four primary-transfer bias rollers **9** are pressed against the corresponding photoreceptor drums **1** via the intermediate transfer belt **8**, and four contact portions between the primary-transfer bias rollers **9** and the corresponding photoreceptor drums **1** are hereinafter referred to as primary-transfer nips. Each primary-transfer bias roller **9** receives a transfer bias whose polarity is opposite the polarity of the toner.

While rotating in the direction indicated by the arrow shown in FIG. **1**, the intermediate transfer belt **8** sequentially passes through the respective primary-transfer nips. Then, the

single-color toner images are transferred from the respective photoreceptor drums **1** primarily and superimposed one on another on the intermediate transfer belt **8**.

Then, the intermediate transfer belt **8** carrying the multicolor toner image reaches a portion facing the secondary-transfer roller **11** disposed facing the secondary-transfer backup roller **10**. The secondary-transfer backup roller **10** and the secondary-transfer roller **11** press against each other via the intermediate transfer belt **8**, and the contact portion therebetween is hereinafter referred o as a secondary-transfer nip. The multicolor toner image formed on the intermediate transfer belt **8** is transferred onto a sheet P (recording medium) transported to the secondary-transfer nip (secondary-transfer process). A certain amount of toner tends to remain on the intermediate transfer belt **8** after the secondary-transfer process.

When the intermediate transfer belt **8** reaches a position facing the belt cleaning unit, any toner remaining on the intermediate transfer belt **8** is collected by the belt cleaning unit. Thus, a sequence of image forming processes performed on the intermediate transfer belt **8** is completed.

The sheet P is transported by the sheet feeder **12** provided in the lower portion of the main body **100** to the secondary-transfer nip via a feed roller **13**, pairs of conveyance rollers **14**, and a pair of registration rollers **15**. More specifically, the sheet feeder **12** contains multiple sheets P piled one on another. When the feed roller **13** is rotated counterclockwise in FIG. **1**, the sheet P on the top is picked up and transported from the sheet feeder **12** to the pair of conveyance rollers **14**.

Then, the conveyance rollers **14** transport the sheet P to the pair of registration rollers **15**. The registration rollers **15** stop the sheet P by clamping the sheet P therebetween and then forward the sheet P to the secondary-transfer nip, timed to coincide with the arrival of the multicolor toner image formed on the intermediate transfer belt **8**. Thus, the multicolor toner image is recorded on the sheet P.

Subsequently, the sheet P onto which the multicolor image is transferred is transported to the fixing device **19**. In the fixing device **19**, the multicolor toner image is fixed on the sheet P with heat from a fixing roller **17** and pressure exerted by a pressure roller **18**.

Then, the sheet P is discharged by a pair of discharge rollers **16** outside the apparatus and stacked on the stack tray **20** as an output image.

Thus, a sequence of image forming processes performed in the image forming apparatus **200** is completed. It is to be noted that the main body **100** of the image forming apparatus **200** further includes a controller **101** that is may be a computer including a central processing unit (CPU) and associated memory units (e.g., ROM, RAM, etc.), for example. The controller **101** performs various types of control processing by executing programs stored in the memory. Field programmable gate arrays (FPGA) may be used instead of the CPU.

Next, a configuration and operation of the development device **5**Y in each image forming unit is described in further detail below with reference to FIG. **2**.

The development device **5**Y includes a development roller **51**Y disposed facing the photoreceptor drum **1**Y, a doctor blade **52**Y disposed facing the development roller **51**Y, a supply screw **56**Y, a collecting screw **57**, an agitation screw **58**Y, and a toner concentration detector to detect the concentration of toner in the developer. A casing of the development device **5**Y serves as a developer container and is divided, at least partially, into a supply compartment **53**Y, a collecting compartment **54**Y, and an agitation compartment **55**Y (also collectively "the developer conveyance compartments **53**Y, **54**Y, and **55**Y") in which the supply screw **56**Y, the collecting screw **57**Y, and the agitation screw **58**Y are respectively provided. The development roller **51**Y includes a magnet roller or multiple magnets fixed in position relative to the casing of the development device **5**Y, a sleeve that rotates around the magnet, and the like. Two-component developer consisting essentially of carrier (carrier particles) and toner (toner particles) is contained in the developer conveyance compartments **53**Y, **54**Y, and **55**Y. The toner contained in the toner container **32**Y is supplied through a port **59**Y formed above the agitation compartment **55**Y.

Arrangement of the components of the development device **5** is described in further detail below.

The supply compartment **53**Y faces the development roller **51**Y, and the developer contained in the supply compartment **53**Y is supplied to the development roller **51**Y. While supplying the developer to the developing roller **51**Y, the supply screw **53**Y provided in the supply compartment transports the developer in an axial direction of the development roller **51**Y toward a back side of paper on which FIG. **2** is drawn. The doctor blade **52**Y, serving as a developer regulator, that adjusts the amount of developer supplied to the development roller **51** to a desired or given layer thickness is positioned downstream from a portion where the development roller **51**Y faces the supply screw **56**Y in a direction in which the development sleeve rotates, indicated by arrow Y**2**.

The collection compartment **54**Y is facing the development roller **51**Y at a position downstream in the rotational direction of the development sleeve from a development area where the development roller **51**Y faces the photoreceptor drum **1**Y. The developer that has passed the development area and been separated from the development roller **51**Y (hereinafter "developer after development") is collected in the collection compartment **54**Y. The collecting screw **57**Y is positioned in parallel to the axial direction of the development roller **51**Y in the collection compartment **54**Y. The collecting screw **57**Y is spiral-shaped and transports the developer in the direction identical or similar to the direction in which the supply screw **56**Y transports the developer (hereinafter "developer conveyance direction"). The developing roller **51**Y and the supply compartment **53**Y in which the supply screw **56**Y is provided are arranged laterally, and the collection compartment **54**Y in which the collecting screw **57**Y is provided is positioned beneath the development roller **51**Y.

It is to be noted that the magnets provided inside the development sleeve are arranged so that no magnetic pole is present in a portion where the developer is to be separated from the development roller **51**Y (release portion) to enable separation of the developer from the development roller **51**Y. Alternatively, the magnets may be arranged to generate a repulsive magnetic field in the portion where the developer is to be separated from the development roller **51**Y.

The agitation compartment **55**Y is positioned beneath the supply compartment **53**Y in parallel to the collection compartment **54**Y. The agitation screw **58**Y provided in the agitation compartment **55**Y is shaped like a spiral and parallels the axial direction of the development roller **51**Y. While agitating the developer, the agitation screw **58**Y transports the developer in the axial direction of the development roller **51**Y toward a front side of paper on which FIG. **2** is drawn, which is opposite the developer conveyance direction by the supply screw **56**Y.

The developing unit **5**Y further includes a first partition **501** including a portion separating the supply compartment **53**Y from the agitation compartment **55**Y. Although separated by the first partition **501**, the supply compartment **53**Y and the agitation compartment **55**Y communicates with each other in both end portions in the direction perpendicular to the

surface of paper on which FIG. **2** is drawn, through openings, namely, a first communication portion and a third communication portion respectively formed on the front side and the back side of paper on which FIG. **2** is drawn.

It is to be noted that the supply compartment **53**Y and the collection compartment **54**Y are separated by the first partition **501** as well, and no opening is formed in that portion of the first partition **501**. Thus, the supply compartment **53**Y does not communicate with the collection compartment **54**Y.

The development device **5**Y further includes a second partition **502** that includes a portion separating the agitation compartment **55**Y from the collection compartment **54**Y. Although separated by the second partition **502**, an opening (second communication portion) through which the agitation compartment **55**Y communicates with the collection compartment **54**Y is formed in the second partition **502**, in an end portion, that is, on the back side of paper on which FIG. **2** is drawn.

The development device **5**Y configured as described above operates as follows.

The development sleeve of the development roller **51**Y rotates in the direction indicated by arrow Y**2** shown in FIG. **2**. The developer held on the development roller **51**Y by the magnetic field generated by the magnets is transported as the development sleeve rotates.

The ratio of the toner to the carrier (the concentration of toner) in the developer contained in the development device **5**Y is adjusted within a predetermined range. More specifically, the toner supply device **60**Y supplies toner from the toner container **32**Y to the agitation compartment **55**Y according to the consumption of toner in the development device **5**Y. The configuration and operation of the toner supply device **60** are described in further detail later.

The toner supplied to the agitation compartment **55**Y is transported to the front side of paper on which FIG. **2** is drawn through the agitation compartment **55**Y by the agitation screw **58**Y while mixed with the developer. The developer that has reached a downstream end portion of the supply compartment **53**Y is supplied therefrom to the supply compartment **53**Y through the opening (first communication portion) of the first partition **501**, which is positioned in the downstream end portion in the developer conveyance direction by the agitation screw **58**Y and in an upstream end portion (proximal end portion) in the developer conveyance direction by the supply screw **54**Y.

Then, the supply screw **56**Y transports the developer supplied from the agitation compartment **55**Y to the supply compartment **53**Y downstream in the supply compartment **53**Y while supplying it to the development roller **51**Y. Then, the developer that is not supplied to the development roller **51**Y (excessive developer) but is transported to the downstream end portion of the supply compartment **53**Y is transported through the opening (third communication portion) formed in the first partition **501** to the agitation compartment **55**Y.

The developer carried on the development roller **51**Y is transported in the direction indicated by arrow Y**2** in FIG. **2** to the doctor blade **52**Y. The amount of the developer on the development roller **51**Y is adjusted to a suitable amount by the doctor blade **52**Y, after which the developer is carried to the development area facing the photoreceptor drum **1**Y. Then, the toner in the developer adheres to the latent image formed on the photoreceptor drum **1**Y due to the effect of the magnetic field generated in the development area. Subsequently, the developer remaining on the development roller **51**Y is separated from the development roller **51**Y and drops to the collection compartment **54**Y. The developer collected from the development roller **51**Y in the collection compartment **54**Y is transported by the collection screw **57**Y to a downstream end portion of the collection compartment **54**Y in the conveyance direction therein, after which the collected developer is transported to the agitation compartment **58**Y through the opening or second communication portion.

While being mixed with the toner supplied to the agitation compartment **55**Y, the excessive developer and the collected developer supplied to the agitation compartment **55**Y are transported by the agitation screw **58**Y through the agitation compartment **55**Y to the front side of paper on which FIG. **2** is drawn. Then, the mixed developer is supplied through the opening or first communication portion of the first partition **501** to the supply compartment **53**Y.

The toner concentration detector is provided beneath the agitation compartment **55**Y, and toner is supplied by the toner supply device **60** from the toner container **32**Y according to outputs from the toner concentration detector. The toner concentration detector may be a magnetic permeability sensor, for example.

Next, a toner supply assembly according to the first embodiment is described below. The toner supply device **60**, the toner container **32**, the toner container mount **31** provided in the main body **100**, and the controller **101** together form the toner supply assembly.

FIG. **3** is a schematic diagram that illustrates supply of toner by the toner supply device **60** from the toner container **32** to the development device **5**, and FIG. **4** is a perspective view of the toner container mount **31**.

Referring to FIG. **4**, the toner container mount **31** serving as a powder container mount includes a bottle fixing portion **70** (powder container engagement portion), bottle guides **80** (powder container guides), a bottle driving unit **90** (powder container driving unit). The toner container **32**Y is installed in and removed from the toner container mount **31** through the bottle fixing portion **70**. The toner container **32**Y is installed in the toner container mount **31** horizontally, which is a direction indicated by arrow X shown in FIG. **4**. It is to be noted that the term "horizontally" used in this specification is not limited to an exact horizontal direction but includes substantially horizontal directions.

Referring to FIG. **3**, the toner container **32** is described below.

The toner container **32**Y according to the present embodiment is a substantially cylindrical toner bottle and includes a cap **32**Y**1** and container body **32**Y**2**. A spiral protrusion **32**Y**2***a* protrudes inward from an inner circumferential face of the container body **32**Y**2**. In other words, a spiral groove is formed in an outer circumferential surface of the toner container **32**Y. In a lower portion of the cap **32**Y**1**, a toner outlet **32**Y**1***a* and toner discharge portion **32**Y**1***d* are provided. The cap **32**Y**1** further includes a plug **32**Y**3** to close the toner outlet **32**Y**1***a*.

The spiral protrusion **32**Y**2***a* is formed on the inner circumferential surface of the toner container **32**Y for discharging the toner in the container body **32**Y**2** to a space (toner reservoir **32**Y**1***k* shown in FIG. **26**) inside the cap **32**Y**1** when the container body **32**Y**2** is rotated in a direction indicated by arrow Y**4** shown in FIG. **3** by the bottle driving unit **90** (shown in FIG. **5**) provided in the main body **100** of the image forming apparatus **200**. As shown in FIG. **5**, the driving unit **90** includes a motor **92**, driving coupling **91**, a spring **93**, and the like. It is to be noted that, reference character **32**Y**2***b* shown in FIG. **3** represents a pair of driving input parts. That is, the container body **32**Y**2** of the toner container **32**Y is rotated by the bottle driving unit **90** as required, thus supplying the toner

from the toner container **32**Y through the toner outlet **32**Y**1***a* formed in the bottom of the space **32**Y**1***k* in the cap **32**Y**1** to the development device **5**.

It is to be noted that, when the respective service life of the toner containers **32**Y, **32**M, **32**C, and **32**K have expired, that is, when almost all toner in the toner container **32** have been consumed, the old one is replaced with a new one. The structure of the toner container **32** is described in further detail later.

Next, referring to FIG. **3**, the toner supply device **60**Y to supply the toner contained in the toner container **32**Y to the development device **5**Y is described in further detail below.

The respective color toners contained in the toner containers **32**Y, **32**M, **32**C, and **32**K in the toner container mount **31** are supplied to the corresponding developing devices **5**Y, **5**M, **5**C, and **5**K by the toner supply devices **60**Y, **60**M, **60**C, and **60**K according to the amount of the corresponding toner consumed. The four toner supply devices **60** have a similar configuration except the color of the toner used therein. The toner supply device **60** includes a screw pump **61**, a conveyance pipe **68**, and a tube **69** connected to the screw pump **61**. The screw pump **61** includes a stator **62**, a suction inlet **63**, a universal joint **64**, a rotor **65**, and a motor **66**.

The plug **32**Y**3** is contained in a nozzle connection compartment or insertion hole **32**Y**1***b* (shown in FIG. **6**) of the toner container **32**Y, and thus the nozzle connection compartment **32**Y**1***b* serves as a tube connection compartment. A nozzle **72**, serving as a tube, of the toner container mount **31** is inserted into the nozzle connection compartment **32**Y**1***b* in conjunction with the installation of the toner container **32**Y. At that time, the plug **32**Y**3** to close the toner container **32**Y is clamped between the nozzle **72** and a pawl **75** and opens the toner outlet **32**Y**1***a* (powder outlet). Then, the toner outlet **32**Y**1***a* communicates with a toner inlet **72***a* (shown in FIGS. **6** and **7**), serving as a powder inlet, formed in one end (first end) portion of the nozzle **72**, and accordingly the toner contained in the container body **32**Y**2** is conveyed through the toner outlet **32**Y**1***a* into the nozzle **72**.

The other end portion (second end portion) of the nozzle **72** is connected to a first end of the tube **69** forming a toner supply route. The tube **69** is formed of a flexible material resistant to toner, and a second end of the tube **69** is connected to the screw pump **61**. For example, the screw pump **61** is a uniaxial eccentric screw pump.

The tube **69** has an inner diameter of within a range of from 4 mm to 10 mm. Examples of the material of the tube **69** include rubbers of polyurethane, nitrile, ethylene-propylene-diene monomer (EPDM), silicone, and the like; and resins of polyethylene, nylon, and the like. Using the flexible tube **69** can enhance flexibility in layout of the toner supply route. Thus, the image forming apparatus **200** can be more compact.

In the present embodiment, the screw pump **61** is a suction-type uniaxial eccentric screw pump. The rotor **65**, the stator **62**, the universal joint **64**, and the like are housed in a casing. The stator **62** is shaped like a female screw or internal thread formed of an elastic material such a rubber, and a double-pitch spiral groove is formed inside the stator **62**. The rotor **65** is formed of a rigid material such as metal and shaped like a male screw, that is, twisted into a spiral. The rotor **65** is inserted in the stator **62** rotatably. One end of the rotor **65** is connected to the motor **66** via the universal joint **64**.

The screw pump **61** as described above generates a suction force at the suction inlet **63** by rotating the rotor **65** inside the stator **62** in a predetermined direction with the motor **66**. In other words, the screw pump **61** generates a negative pressure inside the tube **69** by evacuating air from the tube **69**. Thus, the toner inside the toner container **32**Y is sucked into the suction inlet **63** via the tube **69** together with the air inside the toner container **32**Y. Then, the toner is attracted into the gap between the stator **62** and the rotor **65** from the suction inlet **63** and conveyed to the side opposite the suction inlet **63**. The toner is further conveyed through the conveyance pipe **68** to the development device **5**Y as indicated by broken arrow Y**5** shown in FIG. **3**.

It is to be noted that, a hopper may be installed between the screw pump **61** and the development device **5**Y for temporarily storing the toner supplied to the development device **5**Y.

Next, the toner container mount **31** of the image forming apparatus **200** in which the toner containers **32** are installed is described in further detail below with reference to FIGS. **5** through **18**.

FIG. **5** is a perspective view of the bottle driving unit **90** provided on the downstream side (dismal side) in the direction in which the toner container **32** is installed (hereinafter "installation direction of the toner container **32**"). The bottle driving unit **90** includes the driving coupling **91**, the motor **92**, the spring **93**, and a shaft **94** as shown in FIG. **5**. The driving coupling **91** is positioned to engage the driving input parts **32**Y**2** formed on the bottom of the container body **32**Y**2** (in FIG. **3**, on the right) opposite the cap **32**Y**1** (see also FIG. **20**). The driving coupling **91** and the motor **92** are connected with each other via the shaft **94** and a gear **95** provided at the shaft **94**. The driving force of the motor **92** is transmitted to the driving coupling **91** via the shaft **94** and the gear **95** and rotates the container body **32**Y**2** of the toner container **32**Y that engages the driving coupling **91** in the predetermined direction. The spring **93** is wound around the shaft **94** and biases the driving coupling **91** to the upstream side (proximal side) in the installation direction of the toner container **32**Y.

More specifically, referring to FIGS. **6** and **7**, the driving coupling **91** is movable reciprocally in parallel to the installation direction of the toner container **32**Y is biased to the upstream side in the installation direction of the toner container **32**Y (to the left in FIG. **6**) by the spring **93**. When the toner container **32**Y moves in the direction indicated by arrow X shown in FIG. **6** and is set in the toner container mount **31**, the driving coupling **91** engaging the driving input part **32**Y**2** moves to the downstream side in the installation direction of the toner container **32**Y (to the right in FIG. **6**), pushed by the toner container **32**Y (see also FIG. **7**). At that time, the driving coupling **91** presses the toner container **32**Y to the upstream side in the installation direction of the toner container **32**Y (to the left in FIG. **7**), urged by the spring **93**. Additionally, as shown in FIGS. **6** and **7**, the toner container **32**Y further includes a handle **32**Y**1***c* provided on a head side (proximal side) of the container body **32**Y**2**, which is on the left in FIGS. **6** and **7**, opposite the dismal side of the container body **32**Y**2** on which the driving input parts **32**Y**2***b* are provided.

In removing the toner container **32**Y from the toner container mount **31**, when the toner container **32**Y is released from the toner container mount **31**, the spring **93** pushes the toner container **32**Y in the direction in which the toner container **32** **32**Y is removed (hereinafter "removal direction"), which is to the left in FIG. **7**. In other words, the toner container **32**Y pops out from an insertion opening (insertion portion) **71**, shown in FIG. **8**, formed in the bottle fixing portion **70** of the toner container mount **31** (pop-up action). Then, users can grip the handle **32**Y**1***c* and remove the toner container **32**Y from the main body **100** of the image forming apparatus **200** easily. It is to be noted that the insertion opening **71**Y is defined by an interior of a cap holder **71**Y-**1** (shown in FIG. **9**) in which the cap of the toner container **32**Y is contained.

Next, the bottle fixing portion **70** is described in further detail below with reference to FIG. **8**.

The bottle fixing portion **70** includes the insertion opening **71** (also shown in FIG. **18**), the nozzle **72**, an antenna board **74** serving as a communication circuit, the pawl **75** to bias the plug **32**Y**3** in the direction to close the toner outlet **32**Y**1***a* of the toner container **32**Y, a fixing and release lever **76** (hereinafter also simply "lever **76**") to fix and release the toner container **32**Y from the toner container mount **31**, a pair of positioning protrusions **78**.

The bottle fixing portion **70** holds the caps **32**Y**1**, **32**M**1**, **32**C**1**, and **32**K**1** of the toner containers **32**Y, **32**M, **32**C, and **32**K not to rotate. That is, the bottle fixing portion **70** includes four cap holders in which the respective caps of the toner containers **32** are housed. The bottle fixing portion **70** includes an upper front case **701** and a lower front case **702** of the bottle fixing portion **70**.

FIGS. **9** and **10** are enlarged perspective views of the lower front case **702**. In FIGS. **9** and **10**, reference character **71-1** represents the cap holder. Referring to FIG. **9**, the lower front case **702** includes the positioning protrusions **78** to set the cap **32**Y**1** in position in conjunction with installation of the cap **32**Y**1**. In the present embodiment, the positioning protrusions **78** protrude from the inner face of the bottle fixing portion **70** defining the cap holder **71**Y**1** in which the cap **32**Y**1** is held. The positioning protrusions **78** extend in the installation direction of the toner container **32**Y and are provided on either side symmetrically about a long axis, that is, a line passing through a center axis of the nozzle **72**.

In each cap holder **71**Y**-1** of the bottle fixing portion **70**, the nozzle **72** extends horizontally, that is, in the installation direction of the toner container **32**. The toner inlet **72***a* serving as the powder inlet is formed in a top portion of the first end portion of the nozzle **7**. That is, the toner inlet **72***a* faces up so as to receive toner from above.

The pawl **75** is positioned in a bottom portion of the bottle fixing portion **70**, beneath the cap **32**Y**1** when the cap **32**Y**1** is fixed in the cap holder **71-1** of the bottle fixing portion **70**. The pawl **75** serves as a biasing member that biases the plug **32**Y**3** in the direction in which the toner outlet **32**Y**1***a* is closed in conjunction with removal of the cap **32**Y**1**. The pawl **75** is supported on the lower case **702** rotatably around a shaft **75***a* (shown in FIGS. **34** and **37**) in both directions as indicated by arrow shown in FIG. **9**. A leaf spring **77** (shown in FIG. **33**) provided beneath the pawl **75**, biases the pawl **75** from a position where the pawl **75** does not hinder installation and removal of the cap **32**Y**1** to a position to contact the plug **32**Y**3**. That is, the pawl **75** is biased upward.

Additionally, the lever **76** to fix and release the toner container **32**Y from the bottle fixing portion **70** is provided on the front of the insertion opening **71** and a lateral side of the insertion opening **71**.

FIG. **11** is a perspective view of the lever **76**. Referring to FIG. **11**, the lever **76** includes a pawl **76***a* to set the toner container **32**Y in position and retain it, a lever portion **76***g*, and a rib **76***c*. Referring to in FIGS. **9** and **10**, the lever **76** can move reciprocally in a horizontal direction (lateral direction in FIGS. **9** and **10**) substantially perpendicular to the installation direction of the toner container **32**Y, which is the direction indicated by arrow Y and the opposite direction. The lever **76** is biased by a spring **76***d* (shown in FIG. **12**) to the insertion opening **71**, that is, to the right in FIGS. **9** and **10**. As shown in FIG. **10**, the user can slide the lever **76** to the position (release position) not to protrude into the insertion opening **71** in the direction indicated by arrow Y, opposite the direction in which the spring **76***d* biases the lever **76**, by pushing the lever portion **76***b* with his/her finger. It is to be noted that, in FIG. **11**, reference character **76***a***1** represents a sloped surface **76***a* of the pawl **76***a*.

FIGS. **12** and **13** are end-on axial views that illustrate relative positions of the cap **32**Y**1** of the toner container **32**Y contained in the toner container mount **31** and the lever **76** from the proximal (upstream) side in the installation direction of the toner container **32**Y. Reference characters **32**Y**1***e*, **32**Y**1***f*, and **32**Y**1***h* respectively represent color discrimination protrusions, an identification chip (ID chip) that is an electronic board (electronic data storage unit), and a pressed portion against which the pawl **76***a* is pressed. In FIG. **12**, the cap **32**Y**1** is fixed in position and retained in the bottle fixing portion **70** by the lever **76**, and, in FIG. **13**, the lever **76** is moved in the direction indicated by arrow Y (to the left in FIG. **13**), and thus the toner container **32** is unlocked.

As described above with reference to FIGS. **6** and **7**, the toner container **32**Y installed in the toner container mount **31** is biased by the driving coupling **91** to the upstream side in the installation direction of the toner container **32**Y (to the front side of paper on which FIG. **12** is drawn). The lever **76** urged by the spring **76***d*, however, hinders removal of the toner container **32**Y when the lever **76** is at the retaining position shown in FIG. **12**, that is, when the lever **76** protrudes into the insertion opening **71**Y (see also FIG. **18**), biased by the spring **76***d*. Thus, the lever **76** can retain the toner container **32**Y in the toner container mount **31**.

Next, operation of the fixing and release lever **76** is described in further detail below.

FIGS. **14** through **17** are schematic views that illustrate installation of the toner container **32**Y into the toner container mount **31** as viewed from the bottom side of the toner container **32**Y on which the toner discharge portion **32**Y**1***d* is provided. Arrow X indicates the installation direction of the toner container **32**Y in the toner container mount **31** (hereinafter "the installation direction X"). Referring to FIG. **14**, when the toner container **32**Y is inserted into the toner container mount **31** in the installation direction X, the toner discharge portion **32**Y**1***d* of the toner container **32**Y contacts the sloped surface **76***a***1** of the pawl **76***a* protruding into the insertion opening **71**Y.

Referring to FIG. **15**, when the toner container **32**Y is inserted further, the portion of the toner discharge portion **32**Y**1***d* in contact with the sloped surface **76***a***1** slides along the sloped surface **76***a***1** and pushes the lever **76** in the direction indicated by arrow Y (hereinafter "direction Y"), opposite the direction in which the spring **76***d* biases the lever **76**. When the pawl **76***a* of the lever **76** is pushed to the release position not to protrude into the insertion opening **71**Y, the lever **76** does not hinder installation of the toner container **32**Y. Then, as shown in FIG. **16**, the toner container **32**Y moves further in the installation direction X with the toner discharge portion **32**Y**1***d* in sliding contact with a tip portion of the pawl **76***a*.

When the toner container **32**Y is fully inserted into the toner container mount **31**, the toner discharge portion **32**Y**1***d* of the toner container **32**Y is positioned downstream (on dismal size) from the lever **76** in the installation direction X. That is, the lever **76** is positioned beneath the lever **76** in FIG. **17**. In this state, the lever **76** that has been in contact with the toner discharge portion **32**Y**1***d* and thus been pressed by it is no longer moved by the toner discharge portion **32**Y**1***d*. Accordingly, the lever **76** moves back in the direction indicated by arrow Z shown in FIG. **17** to the retaining position where the lever **76** protrudes into the insertion opening **71** as shown in FIG. **12**. The toner container **32**Y is clamped between the driving coupling **91** of the bottle driving unit **90**

and the lever **76**, thereby fixed in position and retained at that position in the installation direction.

Next, removal of the toner container **32** from the toner container mount **31** of the image forming apparatus **200** is described below.

When the user moves the lever portion **76***b* with his/her finger in the direction opposite the direction indicated by arrow Z shown in FIG. **17**, in which the spring **76***d* biases the lever **76**, thereby sliding the lever **76** with the toner container **32**Y installed in the toner container mount **31**, the pawl **76***a* moves to the release position not to protrude into the insertion opening **71**. Thus, the toner container **32**Y is released. Because the driving coupling **91** of the bottle driving unit **90** biases the toner container **32**Y, the toner container **32**Y pops out from the insertion opening **71** in the direction opposite the installation direction X shown in FIG. **16**. Therefore, the pawl **76***a* of the lever **76** comes into contact with the toner discharge portion **32**Y**1***d* of the toner container **32**Y, which prevents the lever **76** from moving to the retaining position. That is, the lever **76** is kept at the release position. Subsequently, when the user grips the handle **32**Y**1***c* and moves the toner container **32**Y in the direction (hereinafter "removal direction") opposite the installation direction X out from the toner container mount **31**, the contact between the pawl **76***a* and the toner discharge portion **32**Y**1***d* is released. Accordingly, the lever **76** returns to the retaining position shown in FIG. **14**, biased by the spring **76***d*.

In the first embodiment, the bottle fixing portion **70** further includes a lever position detector **79** shown in FIGS. **40**A through **40**D for detecting the position of the lever **76**. For example, the lever position detector **79** is a photosensor. More specifically, referring to FIGS. **40**A through **40**D, the lever position detector **79** that in the present embodiment is a transmissive photosensor is positioned adjacent to the lever **76**. FIG. **40**A is a perspective view that illustrates relative positions of the lever **76** and the lever position detector **79** when the lever **76** is at the retaining position. FIG. **40**B is a schematic top view that illustrates the relative positions of the lever **76** and the lever position detector **79** when the lever **76** is at the retaining position. FIG. **40**C is a perspective view that illustrates relative positions of the lever **76** and the position detector **79** when the lever **76** is at the release position. FIG. **40**D is a schematic top view that illustrates the relative positions of the lever **76** and the position detector **79** when the lever **76** is at the release position.

The lever position detector **79** is positioned so that, when the lever **76** is positioned at the retaining position, the rib **76***c* of the lever **76** is positioned between the light-emitting element and the light-receiving element of the lever position detector **79**, thus blocking the light emitted from the light-emitting element of the lever position detector **79** as shown in FIGS. **40**A and **40**B. Thus, the lever position detector **79** can recognize that the lever **76** is at the retaining position, and the output of the photosensor is on in this state. By contrast, when the lever **76** is moved to the release position, the rib **76***c* moves away from the position between the light-emitting element and the light-receiving element of the lever position detector **79**. Thus, the light-receiving element can receive the light from the light-emitting element, and the output of the photosensor is off in this state.

Although the transmission-type photosensor is used as the position detector in the present embodiment, alternatively, a reflection-type photosensor may be used to detect the lever **76**. Moreover, although in the description above, the rib **76***c* provided on the lever **76** is used in detecting the lever **76** and switching the output of the lever position detector **79**, the output of the lever **76** may be switched differently. For example, the output from the lever position detector **79** may be switched by detecting another component that moves in conjunction with the movement of the lever **76**.

Next, the insertion opening **71** is described in further detail below.

When a cover (not shown) provided on the front side of the main body **100** is opened, the toner container mount **31** is exposed. More specifically, as shown in FIG. **18**, the bottle fixing portion **70** in which the four insertion openings **71** are formed is exposed when the cover of the main body **100** is opened. Attachment and removal of the toner containers **32**Y, **32**M, **32**C, and **32**K are performed from the front side of the image forming apparatus **200** in the longitudinal direction of the toner containers **32**Y, **32**M, **32**C, and **32**K.

It is to be noted that the shape of the insertion openings **71**Y, **71**M, **71**C, and **71**K are different.

More specifically, referring to FIG. **18**, the interiors of the can holders **71**Y-**1**, **71**M-**1**, **71**C-**1**, and **71**K-**1** defining the insertion openings **71**Y, **71**M, **71**C, and **71**K include first guide grooves **71**Y**1**, **71**M**1**, **71**C**1**, and **71**K**1** that engage the color discrimination protrusions **32**Y**1***e*, **32**M**1***e*, **32**Ce, and **32**Ke provided on the caps of the toner containers **32**Y, **32**M, **32**C, and **32**K, respectively. The color discrimination protrusions **32**Y**1***e*, **32**M**1***e*, **32**Ce, and **32**Ke are shown in FIGS. **22** and **28** through **31**. At least one of the shapes, the arrangement, and the quantities of the first guide grooves **71**Y**1**, **71**M**1**, **71**C**1**, and **71**K**1** are different among the four colors so that the insertion opening **71** of specific color can accommodate the toner container **32** of corresponding color, thus prevent a toner container of wrong color from being set in the insertion opening **71** or the toner supply device **60**. In the configuration shown in FIG. **18**, three first guide grooves **71**Y**1**, **71**M**1**, **71**C**1**, and **71**K **1** are formed for each color.

Additionally, referring to FIG. **8**, the antenna boards **74** are set in the upper front case **701** of the bottle fixing portion **70** (toner supply devices **60**Y, **60**M, **60**C, and **60**K) in which the toner containers **32**Y, **32**M, **32**C, and **32**K are removably installed in parallel to each other. More specifically, the antenna boards **74** are arranged on an identical face in an upper portion of the upper front case **701** so as to face the electronic boards **32**Y**1***f*, **32**M**1***f*, **32**C**1***f*, and **32**K**1***f* provided on circumferential surfaces of the toner containers **32**Y, **32**M, **32**C, and **32**K inserted through the bottle fixing portion **70**, a part of which is formed by the upper font case **701**, and arranged in parallel to each other. The electronic boards **32**Y**1***f*, **32**M**1***f*, **32**C**1***f*, and **32**K**1***f* are shown in FIGS. **22** and **28** through **31**.

The electronic boards **32**Y**1***f*, **32**M**1***f*, **32**C**1***f*, and **32**K**1***f* of the toner containers **32**Y, **32**M, **32**C, and **32**K exchange data with the main body **100** in which the antenna boards **74** are provided. The data exchanged between the toner container **32**Y, **32**M, **32**C, and **32**K and the image forming apparatus **200** includes, for example, the production serial number of the toner container, the number of times the toner container is reused, the production lot number, the production date, the color of the toner, and usage history of the image forming apparatus **200**. Other data may also be included. Further, data including the amount of toner remaining in the toner container **32** (hereinafter "the amount of remaining toner") is written in the electronic boards **32**Y**1***f*, **32**M**1***f*, **32**C**1***f*, and **32**K**1***f* as required in accordance with the amount of toner consumed.

It is to be noted that, in the first embodiment, the antenna boards **74** are positioned above the respective toner containers **32** as shown in FIG. **8**. In other words, a receiving face of each antenna board **74** faces down.

This arrangement can eliminate the possibility of drop of toner on the receiving face of the antenna board **74**, thus preventing decreases in the communication sensitivity caused by the toner present between the electronic boards **32**Y**1***f*, **32**M**1***f*, **32**C**1***f*, and **32**K**1***f* and the respective antenna boards **74** if toner drops on the antenna boards **74**.

Next, the toner containers **32** are described in further detail below with reference to FIGS. **19** through **37**.

FIGS. **19** and **20** are perspective views illustrating the toner container **32**Y. In FIG. **19**, reference character **32**Y**1***i* represents a pair of second grooves, **32**Y**1***g* represents a pair of first grooves, and **32**Y**1***n* represents a face of the cap **32**Y**1** perpendicular to the installation direction. In FIG. **20**, reference character **32**Y**1***m* represents ribs (sliding contact portions) extending in the installation direction, and reference character **32**Y**1** represents a nozzle inlet.

FIG. **21** is a perspective view of the container body **32**Y**2**. As shown in FIG. **21**, the container body **32**Y**2** includes an opening **32**Y**2***c* formed in a head portion, which is on the upstream side (proximal side) in the installation direction of the toner container **32**Y into the image forming apparatus **200**, and thus the interior of the container body **32**Y**2** communicates with the interior of the cap **32**Y**1**. The spiral-shaped protrusion **32**Y**2***a* is formed in the inner circumferential surface of the container body **32**Y**2**. Further, as shown in FIG. **20**, the driving input parts **32**Y**2***b* are provided on the bottom of the container body **32**Y**2**, which is on the downstream side (dismal side) in the installation direction of the toner container **32**Y. The driving input parts **32**Y**2***b* engage the driving coupling **91** of the main body **100**. With this configuration, the container body **32**Y**2** rotates in the predetermined direction, receiving the driving force from the driving coupling **91** of the main body **100**, thereby transporting the toner contained therein to the opening **32**Y**2***c*. The toner discharged from the opening **32**Y**2***c* of the container body **32**Y**2** is then stored in the space (toner reservoir **32**Y**1***k* shown in FIG. **26**) inside the cap **32**Y**1**. The toner stored in that space is supplied to the development device **5**Y through the toner outlet **32**Y**1***a* formed beneath that space as also shown in FIG. **27**.

It is to be noted that, as shown in FIG. **20**, the two driving input parts **32**Y**2***b* that engage the two pawls of the driving coupling **91**, respectively, are arranged at angle positions different 180 degrees from each other with reference to the center of rotation of the container body **32**Y**2** in the first embodiment. Alternatively, the driving coupling **91** may have three pawls and the number of the driving input parts **32**Y**2***b* provided in the toner container **32**Y may be three accordingly. The three driving input parts **32**Y**2***b* can be arranged at identical angle intervals with reference to the center of rotation of the container body **32**Y**2**. Although such an arrangement can alleviate fluctuations in the torque when the toner container **32**Y rotates, the probability of interference between the driving input parts **32**Y**2***b* and the pawls of the driving coupling **91** can increase as the number of the driving input parts **32**Y**2***b* (pawls) increases. Therefore, it is preferred to determine the number of the driving input parts **32**Y**2***b* (pawls) considering the adverse effects of the fluctuation in the torque on discharge performance of the toner from the toner container **32**Y as well as the interference between the driving input parts **32**Y**2***b* and the pawls of the driving coupling **91** that inhibits reliable attachment of the toner container **32**.

Next, the cap **32**Y**1** according to the first embodiment is described in further detail below with reference to FIGS. **22** through **31**.

FIGS. **22** and **23** are perspective views of the cap **32**Y**1**, and FIG. **24** is a set of six sides views. It is to be noted that reference character **32**Y**1***q* represents a pair of third grooves.

When inserted into the toner container mount **31**, the cap **32**Y**1** is held and fixed in position relative to the toner container mount **31** (main body **100**). In other words, after fully inserted into the toner container mount **31**, the cap **32**Y**1** does not rotates, and only the container body **32**Y**2** can rotates relative to the main body **100**.

It is to be noted that, referring to FIGS. **26** and **27**, the gap between the cap **32**Y**1** and the container body **32**Y**2** is filled with a seal **32**Y**20***a* attached to a handle body **32**Y**20** of the cap **32**Y**1**, securing the sealing therebetween. More specifically, a rim of the container body **32**Y**2** defining the opening **32**Y**2***c* extends into the seal **32**Y**20***a* and slides on the seal **32**Y**20***a*, and thus toner does not leak out from the gap between the container body **32**Y**2** and the cap **32**Y**1**.

Referring to FIGS. **22** and **23**, the cap **32**Y**1** includes the electronic board **32**Y**1***f*, the protrusions **32**Y**1***e* for color discrimination, the handle **32**Y**1***c*, and the toner discharge portion **32**Y**1***d* as described above. Additionally, the pair of first grooves **32**Y**1***g* is provided in either side surface (in parallel to the installation direction) of the toner discharge portion **32**Y**1***d* of the cap **32**Y**1** as engagement portions that engage the respective positioning protrusions **78** of the toner container mount **31**. Referring to FIGS. **22** and **24**, each first groove **32**Y**1***g* is defined by a pair of horizontal faces **32**Ylga and **32**Y**1***gb* facing each other, extending in the installation direction of the toner container **32**Y in the main body **100**, and a vertical face **32**Y**1***gc* positioned between the and horizontal faces **32**Ylga and **32**Y**1***gb*, extending in the installation direction as well. The cap **32**Y**1** does not rotate in conjunction with the rotation of the container body **32**Y**2** but is retained stationary by the bottle fixing portion **70** of the toner container mount **31** with the first grooves **32**Y**1***g* engaged with the positioning protrusions **78**.

FIG. **25** is an exploded perspective view of the cap **32**Y**1**. The cap **32**Y**1** includes a cap body **32**Y**10**, the handle body **32**Y**20**, and a nozzle insertion portion **32**Y**30**. FIG. **26** is a perspective view of the handle body **32**Y**20** as viewed in the direction indicated by arrow A shown in FIG. **25**. FIG. **27** is a cross-sectional view around the cap **32**Y**1** of the toner container **32**.

The handle body **32**Y**20** is fitted into the cap body **32**Y**10**, that is, the handle body **32**Y**20** is partly covered with the cap body **32**Y**10**. In the configuration shown in FIGS. **25** and **26**, the handle body **32**Y**20** includes multiple ribs **32**Y**20***b*, and edge faces of the ribs **32**Y**20***b* are bonded or welded to an inner circumferential face of the cap body **32**Y**10**. A recess is formed in a lower portion of the handle body **32**Y**20** in FIG. **26**, and the nozzle insertion portion **32**Y**30** is fitted in the recess as shown in FIG. **27**.

Referring to FIG. **25**, the electronic board **32**Y**1***f* and the protrusions **32**Y**1***e* for color discrimination are provided on the outer circumferential surface of the cap body **32**Y**10**. The handle body **32**Y**20** further includes the handle **32**Y**1***c*, projecting in parallel to the installation direction of the toner container **32**Y from a circular face of a cylindrical portion of the handle body **32**Y**20**, and the toner discharge portion **32**Y**1***d* positioned beneath the cylindrical portion. Referring to FIG. **26**, inside the cylindrical portion, the toner reservoir **32**Y**1***k* (hollow) for temporarily storing toner and a cylindrical communication portion **32**Y**1***p* through which the toner reservoir **32**Y**1***k* and the toner discharge portion **32**Y**1***d* communicate with each other are provided. The toner discharge portion **32**Y**1***d* includes the pair of first grooves **32**Y**1**g, the pressed portion **32**Y**1***h*, and the nozzle inlet **32**Y**1***j*. Addition-

ally, a seal **32Y30***c* enclosing the nozzle inlet **32Y1***j* is provided. The seal **32Y30***c* can prevent leakage of toner from the gap between the nozzle **72** and the nozzle inlet **32Y1***j* when the toner container **32**Y is set in the toner container mount **31**. The seal **32Y30***c* also serves as a cushion for absorbing the impact when the toner container **32**Y is slid in the toner container mount **31** and then is fully inserted therein.

Further, referring to FIGS. **25** and **27**, the nozzle insertion portion **32Y30** includes the nozzle connection compartment **32Y1***b* (also shown in FIG. **6**) to accommodate the plug **32Y3**, the toner outlet **32Y1***a* positioned above the nozzle connection compartment **32Y1***b*, through which the toner reservoir **32Y1***k* communicates with the nozzle connection compartment **32Y1***b*, and a toner discharge path **32Y30***a* formed inside the cylindrical communication portion **32Y1***p* formed beneath the toner reservoir **32Y1***k*. The toner is discharged from the toner reservoir **32Y1***k* through the toner discharge path **32Y30***a* to the toner outlet **32Y1***a*. and the nozzle connection compartment **32Y1***b* into which the nozzle **72** of the toner container mount **31** is inserted. The handle **32Y1***c* is When the nozzle insertion portion **32Y30** is fitted the recess formed in the toner discharge portion **32Y1***d*, the nozzle connection compartment **32Y1***b* communicates with the nozzle inlet **32Y1***j* of the toner discharge portion **32Y1***d*.

As shown in FIG. **27**, the plug **32Y3** housed inside the nozzle connection compartment **32Y1***b* includes a cylindrical portion and a planar projection provided on an end of the cylindrical portion, projecting symmetrically. The plug **32Y3** moves inside the nozzle connection compartment **32Y1***b*, thereby opening and closing the toner outlet **32Y1***a*. A planar projection **32Y3**A is provided on the upstream end (proximal end) of the plug **32Y3** in the installation direction of the toner container **32**Y and extends horizontally, in the direction perpendicular to the center axis of the cylindrical portion. The pawl **75** of the toner container mount **31** engages the planar projection **32Y3**A (see also FIG. **34**) of the plug **32Y3**, and accordingly the pawl **75** pushes the plug **32Y3** in the direction to close the toner outlet **32Y1***a* in conjunction with removal of the toner container **32**Y from the toner container mount **31**.

Additionally, a spring **32Y30***b* to bias the plug **32Y3** in the direction to close the toner outlet **32Y1***a* may be provided. The spring **32Y30***b* also can move the plug **32Y3** in the direction to close the toner outlet **32Y1***a* with its bias force when the toner container **32**Y is removed. The spring **32Y30***b* is preferable in that leakage of toner from the toner outlet **32Y1***a* can be reduced because the spring **32Y30***b* can accelerate the initial action of the plug **32Y3** moving in the direction to close the toner outlet **32Y1***a*. Although the plug **32Y3** can be moved in the direction to close the toner outlet **32Y1***a* by either the engagement between the plug **32Y3** and the pawl **75** or the bias by the spring **32Y30***b*, using both is preferable because the leakage of toner from the toner outlet **32Y1***a* can be better prevented. It is to be noted that, in the first embodiment, the image forming apparatus **200** includes both of the pawl **75** and the spring **32Y30***b*.

In FIG. **27**, the plug **32Y3** for opening and closing the toner outlet **32Y1***a* in conjunction with removal of the toner container **32**Y is positioned in the nozzle connection compartment **32Y1***b*.

O-rings **32Y30***d* and **32Y30***e* are provided on both ends of the plug **32Y3** to prevent leakage of toner from the gap between the plug **32Y3** and the nozzle connection compartment **32Y1***b*. Additionally, an O-ring **32Y30***c* is fitted around a circumferential surface of the portion of the nozzle insertion portion **32Y30** forming the toner discharge path **32Y30***a* to prevent leakage of toner from the gap between the handle body **32Y20** and the nozzle insertion portion **32Y30**. The downstream end or dismal end (on the right in FIG. **27**) of the nozzle connection compartment **32Y1***b* in the installation direction of the toner container **32**Y into the main body **100** communicates with the nozzle inlet **32Y1***j*. The nozzle **72** is inserted into the nozzle inlet **32Y1***j* in conjunction with installation of the toner container **32**Y in the toner container mount **31** as shown in FIGS. **6** and **7**.

Further, the pair of second grooves **32Y1***i* is formed in the outer bottom surface of the cap **32Y1**. The plug **32Y3** moves relatively to the cap **32Y1** as the cap **32Y1** moves with the second grooves **32Y1***i* engaged with the pawl **75** of the main body **100**. Moreover, the pair of third grooves **32Y1***q* is formed in the outer bottom surface of the cap **32Y1** in line with the second grooves **32Y1***i*. That is, when viewed in the installation direction of the toner container **32**Y, the second grooves **32Y1***i* overlap with the third grooves **32Y1***q*. A slidable surface **32Y1***r* to slide down the pawl **75** is formed between the second grooves **32Y1***i* and the third grooves **32Y1***q* so that the pawl **75** does not hinder installation of the toner container **32**Y. An edge of the slidable surface **32Y1***r* on the side of the pair of third grooves **32Y1***q* is sloped to push down the pawl **75** smoothly.

The electronic board **32Y1***f* provided on the upper face of the cap **32Y1** is a radio frequency identification (RFID) chip, for example, and is used for exchanging the data relating to the toner container **32**Y and the main body **100** with the main body **100** (antenna board **74**) as described above with reference to FIG. **8**. The electronic board **32Y1***f* is positioned opposite the nozzle connection compartment **32Y1***b* relative to the long axes of the toner container **32**Y. This arrangement can prevent toner adhering to a vicinity of the nozzle connection compartment **32Y1***b* from dropping on the electronic board **32Y1***f* and a resultant deterioration in the communication sensitivity.

Further, referring to FIG. **22**, the handle **32Y1***c* is provided on the upstream side of the cap **32Y1** in the installation direction of the toner container **32**Y, and the user can grip the handle **32Y1***c* to install or remove the toner container **32**Y from the main body **100**. The handle **32Y1***c* is provided on the face of the cap **32Y1** opposite the face in which the nozzle inlet **32Y1***j* is formed, projecting in the removal direction of the toner container **32**Y from the main body **100**. This arrangement can reduce the possibility that the user unintentionally touches the nozzle inlet **32Y1***j*, to which toner tends to adhere, when the user grips the handle **32Y1***c*.

Referring to FIGS. **22** and **28** through **31**, descriptions are given below of preventing toner containers of wrong type from being inserted into the insertion opening **71** and preventing leakage of the toner therefrom when users mistakenly try to install the toner container of the wrong type in the toner container mount **31**.

The color discrimination protrusions **32Y1***e* are configured to prevent toner containers **32**M, **32**C, and **32**K of other colors from being inserted into the insertion opening **71**Y (toner supply device **60**Y) for yellow as described above with reference to FIG. **18**. More specifically, the color discrimination protrusions **32Y1***e* for yellow shown in FIG. **28**, the color discrimination protrusions **32M1***e* for magenta shown in FIG. **29**, the color discrimination protrusions **32C1***e* for cyan shown in FIG. **30**, and the color discrimination protrusions **32K1***e* for black shown in FIG. **31** are different in at least one of arrangement, shape, and quantity so as to fit only the first guide grooves **71Y1**, **71M1**, **71C1**, and **71K1** of the corresponding insertion openings **71**Y, **71**M, **71**C, and **71**K (shown in FIG. **18**), respectively.

In the first embodiment, referring to FIG. **27**, in the installation direction of the toner container **32**Y into the main body

100, a downstream end (dismal end) of the rim defining the toner outlet 32Y1*a* is positioned at a position E2 upstream (proximal side) from a position E1 of a downstream end 32Y1*e*-1 of the protrusions 32Y1*e* for color discrimination. With this arrangement, even when the toner container 32 of wrong color is inserted into the insertion opening 71Y for yellow, that toner container 32 cannot be inserted further from the downstream end of the color discrimination protrusions 32M1*e*, 32Cle, or 32Kle in the installation direction because the color discrimination protrusions 32M1*e*, 32C1*e*, or 32Kle interfere with insertion opening 71Y. Consequently, the nozzle 72 is not inserted into the nozzle inlet 32M1*j*, 32C1*j*, or 32K1*j*, and the toner outlet 32M1*a*, 32C1*a*, or 32Kla is not opened. Thus, toner does not leak out through the toner outlet 32M1*a*, 32C1*a*, or 32K1*a*, or drop inside the toner container mount 31. Also, toner does not scatter in the portion of the toner container mount 31 for different color.

When the toner container 32Y is installed in the toner container mount 31, the pressed portion 32Y1*h* is pressed against the pawl 76*a* of the lever 76 and thus held in the toner container mount 31. More specifically, the pressed portion 32Y1*h* is positioned to be pressed against the lever 76 when the position of the toner container 32Y, which is biased by the driving coupling 91 and held by the lever 76, is determined in the installation direction. Referring to FIG. 22, the pressed portion 32Y1*h* is constructed of the face 32Yln of the cap 32Y1 perpendicular to the installation direction and two projections, such as ribs, projecting in the direction in the removal direction of the toner container 32Y. The pressed portion 32Y1*h* is pressed against the lever 76 with the bias force from the dismal side to the proximal side, exerted by the driving coupling 91. The apexes of the two projections can enhance accuracy in the registration of the toner container 32Y in the installation direction.

Referring to FIG. 22, the ribs (sliding contact portion) 32Y1*m* extending in the installation direction are provided on the back side of the face 32Y1, opposite the side on which the pressed portion 32Y1*h* is formed. In other words, the ribs 32Y1*m* extend in parallel to the direction in which the pressed portion 32Y1*h* projects. As described above with reference to FIGS. 14 through 17, the sliding contact portion 32Y1*m* slides on the lever 76 and keeps the position of the lever 76 at the release position, at which the lever 76 does not prevent insertion or removal of the toner container 32Y, when the toner container 32Y is inserted or removed from the toner container mount 31. Additionally, the sliding contact portion 32Y1*m* can secure the strength of the face 32Y1 on which the pressed portion 32Y1*h* is formed. Further with reference to FIG. 22, the upper one of the two ribs serving as the sliding contact portion 32Y1*m* forms the horizontal face 32Y1*gb* that forms the first groove 32Y1*g*.

Descriptions are given below of opening and closing the toner outlet 32Y1*a* when the toner container 32Y is installed and removed from the toner container mount 31 with reference to FIGS. 32 through 37.

FIGS. 32 through 34 are schematic cross-sectional views in parallel to the long axis of the toner container 32Y that illustrate progress of insertion of the toner container 32Y into the toner container mount 31 in the installation direction X. FIG. 35 is a schematic cross-sectional views in parallel to the long axis of the toner container 32Y that illustrate in the toner container 32Y fully inserted in the toner container mount 31 and the toner outlet 32Y1*a* is opened fully. FIG. 36 is a perspective view that illustrates relative positions of the nozzle 72, the pawl 75, and the lever 76 provided in the toner container mount 31. FIG. 37 is a side view in parallel to the long axis of the toner container 32Y that illustrates relative positions of the nozzle 72, the pawl 75, and the lever 76. In FIG. 37, the toner container 32Y to be inserted into the toner container mount 31 moves from the left to the right. Referring to FIG. 37, the lever 76, the pawl 75, and the nozzle 72 are arranged, in that order, in the installation direction of the toner container 32Y.

To mount the toner container 32Y in the toner container mount 31 of the main body 100, initially the cover provided on the front side of the main body 100 is opened, and thus the toner container mount 31 (insertion openings 71) is exposed on the front side.

Subsequently, the user grips the handle 32Y1*c* and push the toner container 32Y into the toner container mount 31. More specifically, the toner container 32Y is inserted into the toner container mount 31 along the longitudinal direction of the toner container 32Y with the cap 32Y1 positioned upstream from the container body 32Y2 in the installation direction.

At that time, downstream end portions of the ribs 32Y1*m* (shown in FIG. 22) in the installation direction, serving as the sliding contact portion, contact the sloped surface 76*a*1 of the pawl 76*a* of the lever 76. The sloped surface 76*a*1 of the pawl 76*a* of the lever 76 is sloped so that the pawl 76*a* extends closer to the toner container 32Y downstream in the installation direction of the toner container 32Y as shown in FIGS. 14 through 17. Accordingly, as insertion of the toner container 32Y progresses, the lever 76 is pushed by the downstream end portions of the ribs 32Y1*m* to the release position not to hinder the insertion of the toner container 32Y. As the toner container 32Y is further inserted with an edge portion of the lever 76 at the release position in sliding contact with the ribs 32Y1*m*, the pawl 75 engages the pair of third grooves 32Y1*q* provided on the bottom face of the toner container 32Y as shown in FIG. 32. At that time, the first grooves 32Y1g of the cap 32Y1 engage the positioning protrusions 78 of the toner container mount 31, thus starting registration of the toner container 32Y.

When the pawl 75 of the toner container mount 31 comes in contact with the slidable surface 32Y1*r* of the cap 32Y1 as the toner container 32Y is inserted further, the pawl 75 is pushed down by a sloped face on the rim of the slidable surface 32Y1*r*. Thus, the pawl 75 is moved to the release position not to hinder insertion of the cap 32Y1. The toner container 32Y is further inserted as the pawl 75 pushed down slides on the slidable surface 32Y1*r* as shown in FIG. 33.

Subsequently, when the pawl 75 reaches the second groove 32Y1*i* as the toner container 32Y is inserted further, the pawl 75 moves from the release position shown in FIG. 33 and projects to the position engaging the plug 32Y3 so as to fit in the second groove 32Y1*i*. That is, the pawl 75 rotates about the shaft 75*a* (shown in FIG. 34). In other words, the slidable surface 32Y1*r* no longer pushes the pawl 75, and then the pawl 75 is pushed up by the leaf spring 77. At that time, a downstream end portion of the plug 32Y3 in the installation direction of the toner container 32Y reaches a position to contact the nozzle 72, and the position of the plug 32Y3, clamped by the nozzle 72 and the pawl 75, is determined relative to the toner container mount 31Y as shown in FIG. 34.

As the toner container 32Y is inserted further in the installation direction X, the nozzle 72 fits in the nozzle inlet 32Y1*j* with the positioning protrusions 78 fitted in the first grooves 32Y1*g*. Accordingly, the plug 32Y3 moves in the nozzle connection compartment 32Y1*b* relatively, thereby opening the toner outlet 32Y1*a*.

Then, referring to FIG. 35, the plug 32Y3 opens the toner outlet 32Y1*a* fully, and the nozzle 72 is inserted into the cap 32Y1 so that the toner inlet 72*a* of the nozzle 72 communicates with the toner outlet 32Y1*a*. Simultaneously, the lever

76 that has moved to the release position and slid on the ribs 32Y1*m* reaches upstream end portions of the ribs 32Y1*m* in the installation direction X and is no longer pushed by the ribs 32Y1*m*. Then, the lever 76 returns to the retaining position, pushed by the spring 76*d* as shown in FIG. 12. Thus, installation of the toner container 32Y is completed.

To remove the toner container 32Y from the toner container mount 31, the above-described processes are executed in the reverse order to that in insertion of the toner container 32Y.

When the lever 76 is moved to the release position, the driving coupling 91 of the toner container mount 31 pushes the toner container 32Y in the removal direction (to the left in FIG. 35). Simultaneously, the spring 32Y30*b* and the pawl 75 in contact with the plug 32Y3 push the plug 32Y3 in the nozzle connection compartment 32Y1*b*, thereby closing the toner outlet 32Y1*a*. At that time, while keeping the release position, the lever 76 slides on the ribs 32Y1*m* on the cap 32Y1 and does not move to the retaining position to hinder removal of the toner container 32Y. Subsequently, when the toner container 32Y is moved from the state shown in FIG. 34, further in the removal direction opposite the installation direction X, the pawl 75 is pushed down to the position not to hinder removal of the cap 32Y1 as shown in FIG. 33. As the toner container 32Y is moved further in the removal direction, the pawl 75 is no longer pushed by the slidable surface 32Y1*r* and then is pushed up by the leaf spring 77. Then, the pawl 75 fits in the third groove 32Y1*q* as shown in FIG. 32. When the cap 32Y1 is removed completely from the toner container mount 31, the lever 76 is not pushed by the rib 32Y1*m* but is moved by the spring 76*d* to the retaining position.

Next, supply of toner from the toner containers 32 according to the first embodiment when one of them is removed (replaced) is described in detail below.

In the image forming apparatus 200 according to the present embodiment, when one of the yellow, cyan, magenta, and black toner containers 32 is removed, for example, for replacement, supply of the toner from other toner containers 32 is not stopped. In other words, the motors 92 for the respective toner containers 32 can be driven independently, and other toner containers 32 in the toner container mount 31 than the one removed therefrom receive driving forces from the respective motors 92. When the cover provided on the front side of the main body 100 is opened, although the toner containers 32 set in the toner container mount 31 are exposed, the container bodies (e.g., 32Y2) that rotate are positioned on the back of the respective caps (e.g., 32Y1). Because the container body 32Y2 is not exposed through the insertion opening 71Y, the possibility that the user touches the rotating container body 32Y2 and gets injured is eliminated even when the toner container 32Y is being driven by the bottle driving unit 90.

The user, however, might get injured in case the driving force is transmitted from the bottle driving unit 90 to the toner container 32 to be removed in removal of that toner container 32. Therefore, the first embodiment can make sure to stop driving of the toner container removed from the toner container mount 31 with driving of other toner containers 32 kept when one of the toner containers is removed.

As described above, the bottle fixing portion 70 includes the position detectors 79 shown in FIGS. 40A through 40D for detecting the positions of the respective levers 76. In the first embodiment, start and stop rotating the toner containers 32, writing data in the electronic boards (ID chips) 32Y1*f*, and supplying toner from the toner containers 32 can be controlled with signals output from the respective position detectors 79. More specifically, the image forming apparatus 200 includes the controller 101 to control start and stop of the bottle driving units 90, data writing in the electronic boards (ID chips) 32Y1*f*, and the toner supply, and the controller 101 performs these control operations according to the signals output from the position detectors 79.

When the output from the lever position detector 79 is on, that is, in the state shown in FIGS. 40A and 40B, the controller 101 drives the motor 92Y as required. The controller 101, however, stops the motor 92Y compulsively even if driving the motor 92Y is necessary, when the output from the lever position detector 79 is off, that is, in the state shown in FIGS. 40C and 40D. More specifically, when the toner container 32Y is set in the toner container mount 31, the lever 76 is at the retaining position, thus retaining the toner container 32Y. At that time, the lever position detector 79 detects the lever 76 and outputs a detection signal. After the toner container 32Y is removed from the toner container mount 31, the lever 76 moves to the retaining position similarly, biased by the spring 76*d*. At that time, if the motor 92 is driven, it is possible that an excessive amount of electrical current might be supplied to the motor 92 because the load is low. Therefore, even when the lever 76 is moved to the retaining position, the controller 101 does not drive the motor 92 unless a container detector detects that the toner container 32Y is set in the toner container mount 31. Thus, the controller 101 drives the motor 92 as required only when the lever position detector 79 detects that the lever 76 is at the retaining position and the container detector detects that the toner container 32Y is set in the toner container mount 31. For example, the antenna boards 74 can serve as the container detector, which is described in detail later.

It is to be noted that, the antenna boards 74 can serve as the container detectors in the present embodiment. More specifically, when it is detected that the antenna board 74Y can communicate the electronic board 32Y1*f*, the controller 101 recognizes that the toner container 32Y is detected. Alternatively, the toner container 32Y may be detected in a manner different from that using the antenna board 74. For example, an insertion detecting switch may be used.

By contrast, in removal of the toner container 32Y, the output from the lever position detector 79 is turned off when the lever 76 is slid to the release position. When the output from the lever position detector 79 is off, the controller 101 stops the motor 92Y compulsively even if the antenna board 74 detects the toner container 32Y, that is, the antenna board 74Y can communicate the electronic board 32Y1*f*, and driving of the motor 92Y is necessary. With this control, the motor 92 can be stopped before removal of the toner container 32Y from the toner container mount 31 is started.

With this configuration, because the motor 92 to rotate the toner container 32Y is started only after the toner container 32Y is retained therein properly, unnecessary downtime is not caused even when the cover of the main body 100 is not closed fully. Even when the cover is left open, the toner containers 32 that are not to be replaced, set in the toner container mount 31, can be kept rotating, and thus eliminating unnecessary downtime.

Further, in installation of the toner container 32Y, although it is possible that the antenna board 74Y can detect the toner container 32Y before the toner container 32Y is inserted fully, that is, moved to an installation position, the motor 92 is not started immediately. The motor 92 is started only after the user moves the toner container 32Y to the installation position, the lever 76 is moved to the retaining position, and the lever position detector 79 detects that the lever 76 is at the retaining position. Additionally, in removal of the toner container 32Y, before removal of the toner container 32Y is

started, the motor **92** is stopped immediately when the lever **76** is moved to the release position and the lever position detector **79** detects that. This configuration can prevent the possibilities that the motor **92** is started before the toner container **32**Y is set in at the installation position, and that the motor **92** is kept rotating after the toner container **32**Y is removed, thus supplying electrical current excessively to the motor **92**. Thus, damage to the motor **92**, the driving coupling **91**, and the driving input parts **32**Y**2***b*, caused by driving the motor **92** at improper timing, can be prevented or reduced.

FIG. **41**A is a schematic side view that illustrates relative positions of the lever **76** and the bottle driving unit **90** in the installation direction of the toner container **32**Y, and FIG. **41**B is a schematic side view of the toner container **32**Y. For simplification and ease of understanding, the toner container mount **31** and the toner container **32**Y shown in FIGS. **41**A and **41**B are those as viewed from the opposite sides. That is, the toner container **32**Y is inserted into the toner container mount **31** from the left to the right in FIG. **41**A. By contrast, the toner container **32**Y is inserted into the toner container mount **31** from the right to the left in FIG. **41**B.

In FIG. **41**A, a distance A is a horizontal length of the toner container mount **31** from an upstream end (proximal end) of the pawl **76***a* of the lever **76** to the driving coupling **91** in the installation direction. In FIG. **41**B, a distance B is a horizontal length from the downstream end portion of the sliding contact portion **32**Y**1***m* of the toner container **32**Y to the driving input parts **32**Y**2***b* in the installation direction. In the present embodiment, the distance B is longer than the distance A.

With this configuration, in inserting the toner container **32**Y into the toner container mount **31**, the driving input parts **32**Y**2***b* do not come into contact with the driving coupling **91** when the toner container **32**Y is inserted to a position where the downstream end portion of the sliding contact portion **32**Y**1***m* of the toner container **32**Y starts to contact the pawl **76***a* (shown in FIG. **14**). When the toner container **32**Y is inserted further backward, the lever **76** slides to the release position, and thus the output from the lever position detector **79** is turned off. Accordingly, driving of the motor **92** of the bottle driving unit **90** is stopped. Therefore, even when the driving input parts **32**Y**2***b* contact the driving coupling **91**, the container body **32**Y**2** of the toner container **32**Y does not rotate. As described above, when the distance A shown in FIG. **41**A is greater than the distance B shown in FIG. **41**B (A>B), unintentional rotation of the container body **32**Y**2** can be prevented when the toner container **32**Y is installed or removed from the toner container mount **31**.

The controller **101** prohibits data writing on the IC chip of the electronic board **32**Y**1***f* unless the container detector detects that the toner container **32**Y is set in the toner container mount **31** even when the lever **76**Y is moved to the retaining position. The controller **101** enables the data writing on the IC chip **32**Y**1***f* as required only when the lever position detector **79** serving as a retaining state detector detects that the lever **76** is at the retaining position and the container detector detects that the toner container **32**Y is set in the toner container mount **31**.

In removal of the toner container **32**Y, the output from the lever position detector **79** is turned off when the lever **76** is slid to the release position. When the output from the lever position detector **79** is off, the controller **101** stops data writing on the IC chip **32**Y**1***f* compulsively even if the antenna board **74**Y detects the toner container **32**Y, that is, the antenna board **74**Y can communicate the electronic board **32**Y**1***f*. This control can inhibits data writing on the IC chip (electronic board) **32**Y**1***f* when the toner container **32**Y is removed from the toner container mount **31**. That is, data writing is not attempted when it is inexecutable. Thus, write errors can be prevented or reduced.

FIG. **42**A is a schematic side view that illustrates relative positions of the lever **76** and the antenna board **74** in the installation direction of the toner container **32**Y, and FIG. **42**B is a schematic side view of the toner container **32**Y. For simplification and ease of understanding, the toner container mount **31** and the toner container **32**Y shown in FIGS. **42**A and **42**B are those as viewed from the opposite sides. That is, the toner container **32**Y is inserted into the toner container mount **31** from the left to the right in FIG. **42**A. By contrast, the toner container **32**Y is inserted into the toner container mount **31** from the right to the left in FIG. **42**B.

In FIG. **42**A, a distance C is a horizontal distance, in the installation direction of the toner container **32**Y, from the upstream end of the pawl **76***a* of the **76** to an upstream end (proximal limit position) of a communicational area in which the antenna board **74** can communicate the electronic board **32**Y**1***f*. In FIG. **42**B, a distance D is a horizontal distance, in the installation direction of the toner container **32**Y, from the downstream end portion of the sliding contact portion **32**Y**1***m* to a downstream end portion of the electronic board **32**Y**1***f*.

In the present embodiment, the distance D shown in FIG. **42**B is greater than the distance C shown in FIG. **42**A (D>C). The distance C is regarded as positive (+) when the proximal limit position of the communicational area is upstream from the proximal end portion the pawl **76***a* in the installation direction X and as negative (−) when the upstream side limit position of the communicational area is downstream from the upstream end portion (proximal end) of the pawl **76***a* in the installation direction X. The distance D is regarded as positive (+) when the downstream end of the electronic board **32**Y**1***f* is upstream from the downstream end portion of the sliding contact portion **32**Y**1***m* in the installation direction X and as negative (−) when the downstream end of the electronic board **32**Y**1***f* is downstream from the downstream end portion the sliding contact portion **32**Y**1***m* in the installation direction X.

When the distance D is thus greater than the distance C, in inserting the toner container **32**Y into the toner container mount **31**, the electronic board **32**Y**1***f* doest not yet enter the communicational area of the antenna board **74** when the downstream end portion of the sliding contact portion **32**Y**1***m* of the toner container **32**Y starts to contact the pawl **76***a* (shown in FIG. **14**). Therefore, before installation of the toner container **32**Y in the toner container mount **31** is completed, driving of the motor **92** and data writing on the electronic board **32**Y**1***f* can be stopped because the output from the antenna board **74** is off outside the communicational area (shown in FIG. **42**A) even of the output of the lever position detector **79** is on.

In the state shown in FIG. **14**, the toner container **32**Y can move because the first grooves **32**Y**1***g* do not fit around the positioning protrusions **78**. If data is written in or read out from the electronic board **32**Y**1***f* in this state, it is possible that the electronic board **32**Y**1***f* is moved outside the communicational area of the antenna board **74** during data writing or reading, resulting in a communication error. Thus, the electronic board **32**Y**1***f* or the antenna board **74**, or both can be damaged seriously. Therefore, the relative positions of the toner container **32**Y and the toner container mount **31** are set so that the distance D is greater than the distance C. With this arrangement, rotation of the toner container **32**Y, and the data writing and reading from the electronic board **32**Y**1***f* can be executed only after the toner container **32**Y is secured in the toner container mount **31**.

Additionally, even when the lever **76** is moved to the retaining position, the controller **101** does not drive the motor **66**Y for driving the screw pump **61**Y unless the container detector detects that the toner container **32**Y is set in the toner container mount **31**. Thus, the controller **101** drives the motor **66**Y as required only when the position detector detects that the lever **76** is at the retaining position and the container detector detects that the toner container **32**Y is set in the toner container mount **31**.

In removal of the toner container **32**Y, the output from the lever position detector **79** is turned off when the lever **76** is slid to the release position. When the output from the lever position detector **79** is off, the controller **101** stops the motor **66**Y compulsively even if the antenna board **74** detects the toner container **32**Y, and driving of the motor **66**Y is necessary. With this control, driving of the screw pump **61**Y can be stopped before removal of the toner container **32**Y from the toner container mount **31** is started and the nozzle **72** is removed from the cap **32**Y**1**.

Further, in installation of the toner container **32**Y, although the antenna board **74** can detect the toner container **32**Y before the toner container **32**Y is inserted fully, that is, moved to the installation position, the motor **66**Y is not started immediately. The motor **66**Y is started only after the user moves the toner container **32**Y to the installation position, the lever **76** is moved to the retaining position, and the lever position detector **79** detects that the lever **76** is at the retaining position. Consequently, the screw pump **61**Y can be driven only after the nozzle **72** is inserted into the cap **32**Y**1** securely.

Therefore, in the present embodiment, the screw pump **61**Y can be prevented from sucking in air in installation or removal of the toner container **32**Y.

Table 1 illustrates relations among time of the various operations, on and off states of outputs from the detectors, and the movements of the respective components.

TABLE 1

Operational timing	Lever position detector	Antenna board communication (insertion detection)	Toner container rotation	Writing on electronic board	Screw pump driving
Toner container secured	ON	OK	Permitted	Permitted	Permitted
Lever released	OFF	OK	Prohibited	Prohibited	Prohibited
Toner container removed	ON	Not available	Prohibited	Prohibited	Prohibited
Installation of new container started	OFF	Switched to OK	Prohibited	Prohibited	Prohibited
New container secured	ON	OK	Permitted	Permitted	Permitted

When the toner container **32**Y is secured at the installation position, the output from the lever position detector **79** is on and the antenna board **74** detects that the toner container **32**Y is "present", that is set in the toner container mount **31**. In this state, rotation of the toner container **32**Y, data writing on the IC chip (electronic board) **32**Y**1***f*, and driving of the screw pump **61**Y are allowed as required. When the lever **76** is released to remove the toner container **32**Y from the toner container mount **31**, the output from the lever position detector **79** is turned off. In this state, rotation of the toner container **32**Y, data writing on the IC chip (electronic board) **32**Y**1***f*, and driving of the screw pump **61**Y are forbidden or stopped compulsively, as described above, even when the antenna board **74** detects that the toner container **32**Y is present. When the toner container **32**Y is removed and is not present in the toner container mount **31**, the output from the lever position detector **79** is on and the antenna board **74** does not detect the toner container **32**Y, that is, regards it as "absent". In this state, rotation of the toner container **32**Y, data writing on the IC chip (electronic board) **32**Y**1***f*, and driving of the screw pump **61**Y are yet forbidden. Further, while a new toner container **32**Y is being installed in the toner container mount **31**, the output from the lever **79** is off and the state of the toner container **32**Y detected by the antenna board **74** changes from "absent" to "present". Because insertion of the toner container **32**Y is not yet completed even when the presence of the toner container **32**Y in the toner container mount **31** is detected, the output from the lever position detector **79** remains off. Accordingly, the rotation of the toner container **32**Y, data writing on the IC chip (electronic board) **32**Y**1***f*, and the driving of the screw pump **61**Y are yet forbidden. When the new toner container **32**Y is set at the installation position, the output from the lever position detector **79** is turned on and the antenna board **74** detects that the toner container **32**Y is present. Therefore, the rotation of the toner container **32**Y, data writing on the IC chip (electronic board) **32**Y**1***f*, and the driving of the screw pump **61**Y are allowed as required.

FIG. **48** is a flowchart that illustrates a sequence of processes for setting operation enabling flags by the controller **101** of the image forming apparatus **200** according to the first embodiment.

The operation enabling flag setting is performed repeatedly, independently for each of yellow, cyan, magenta, and black, when a main power of the image forming apparatus **200** is on. Referring to FIG. **48**, at S**1** the controller **101** checks the output from the lever position detector **79** and, at S**2**, checks the insertion state of the toner container **32** detected by the antenna board **74**. When the output from the lever position detector **79** is on (Yes at S**1**) and it is detected that the toner container **32** is present (Yes at S**2**), at S**3** the operation enabling flag is turned on. In other cases, at S**4** the operation enabling flag is turned off.

FIG. **49** is a flowchart that illustrates a sequence of processes for allowing or forbidding rotation of the toner container **32** by the controller **101** according to the first embodiment.

The controller **101** allows or inhibits rotation of the toner container **32** for yellow, cyan, magenta, and black, independently. Referring to FIG. **49**, at S**11** the controller **101** checks whether or not a predetermined driving time has come and, at S**12**, checks whether the operation enabling flag is on. When the predetermined driving time has come (Yes at S**11**) and the operation enabling flag is on (Yes at S**12**), at S**13** the motor **92** is driven. In other cases, at S**14** the motor **92** is stopped or is prevented from rotating. With this control, the motor **92** for rotating the toner container **32** can be preventing from rotat-

ing at improper timing, that is, during installation and removal of the toner container **32**.

It is to be noted that processes for allowing and prohibiting data writing on the IC chip (electronic board) **32Y1***f* for each color are similar to the above-described allowance and prohibition of the motor **92** for rotating the toner container **32**. More specifically, data writing on the IC chip (electronic board) **32Y1***f* is executable only when a predetermined data writing time has come and the operation enabling flag is on. In other cases, data writing is topped or prohibited. With this control, data writing on the IC chip (electronic board) **32Y1***f* can be prevented at improper timing, thus preventing occurrence of resulting write errors.

FIG. **50** is a flowchart that illustrates processes for allowing and forbidding driving of the screw pump **61** by the controller **101**.

Allowing and forbidding driving of the screw pump **61** are performed for yellow, cyan, magenta, and black, independently. Allowing and forbidding driving of the screw pump **61** are performed on the premises that the controller **101** calculates the amount of toner remaining in the toner container **32** based on printing time, for example, and regularly renews the amount of remaining toner stored on the IC chip (electronic board) **32Y1***f* of the toner container **32**, that is, replaces the stored amount of remaining toner with the latest amount of remaining toner calculated. Therefore, even when the toner container **32** is replaced with used one, the controller **101** can recognize the amount of toner remaining in that toner container **32**.

Referring to FIG. **50**, at S**21** the controller **101** checks whether or not a predetermined driving time for driving the motor (e.g., **66**Y) to drive the screw pump **61** has come and, at S**22**, checks whether the operation enabling flag is on. The processes for allowing and forbidding driving of the screw pump **61** are similar to those for rotating the toner container **32** shown in FIG. **49** so far. Subsequently, the controller **101** makes a determination that is not included in the processes shown in FIG. **49**. More specifically, at S**23** the controller **101** retrieves the amount of remaining toner stored on the IC chip (electronic board) **32Y1***f* of the toner container **32**. Then, the controller **101** determines whether or not the retrieved amount of remaining toner is greater than a given threshold amount, that is, the amount of toner remaining in the toner container **32** is sufficient. At S**24**, the controller **101** drives the motor **66** for driving the screw pump **61** only when the predetermined driving time has come (Yes at S**21**), the operation enabling flag is on (Yes at S**22**), and the amount of remaining toner in the toner container **32** is sufficient (Yes at S**23**). In other cases, the controller **101** stops or prevent the motor **66** from rotating. With this control, the screw pump **61** can be preventing from rotating at improper timing, that is, during installation and removal of the toner container **32**. Additionally, even when the toner container **32** is retained at the installation position, driving of the screw pump **61** is not allowed when the amount of remaining toner is insufficient. Accordingly, the screw pump **61** can be prevented from sucking in air through the empty toner container **32**.

It is to be noted that the amount of remaining toner to be stored on the ID chip can be calculated using the cumulative number of dots output after the toner container **32** is replaced, obtained from image data for each printing or each output sheet. Alternatively, the amount of remaining toner may be calculated based on the cumulative time period during which the toner container **32** is rotated after the toner container **32** is replaced. Yet alternatively, the amount of remaining toner may be calculated based on the driving torque of the motor **92** for rotating the toner container **32**, detected by a torque detector.

(Second Embodiment)

A second embodiment is described below with reference to FIG. **38**.

FIG. **38** is a schematic cross-sectional view of a toner container **32Y-2** according to the second embodiment. The toner container **32Y-2** according to the second embodiment is different from the toner container **32Y** in the first embodiment in that a conveyance member **320** is provided in a container body **32Y2-2**.

As shown in FIG. **38**, the toner container **32Y-2** in the second embodiment includes the container body **32Y2-2** and the conveyance member **320** provided inside the container body **32Y2-2**. The container body **32Y2-2** is retained such a way as not to rotate by the main body **100** when the toner container **32Y-2** is installed in the toner container mount **31**. Although, in the first embodiment, the toner is conveyed along the spiral protrusion **32Y2***a* (shown in FIG. **21**) formed in the inner circumferential face of the container body **32Y2** as the container body **32Y2** rotates, the toner is conveyed by the conveyance member **320** in the second embodiment. Because the container body **32Y2-2** does not rotate, a cap and the container body **32Y-2** may be united as a single unit. Needless to say, the toner container **32Y-2** may include a separate cap similarly to the first embodiment.

A shaft of the conveyance member **320** is rotatively supported by the head side and the bottom side of the container body **32Y2-2**. The member **320** includes multiple agitation blades **320***a* connected to or continuous with the shaft of the conveyance member **320** and a driving input part **321** provided on the bottom side, that engages the driving coupling **91**. The driving input part **321** may be a driven coupling, for example. With this configuration, the conveyance member **320** rotates and transports the toner inside the toner container **32Y-2** in its longitudinal direction (in FIG. **38**, to the left), receiving a driving force from the driving coupling **91** of the main body **100**. Thus, the toner is discharged through the toner outlet **32Y1***a* to the nozzle **72**.

In the second embodiment, the container body **32Y2-2** includes the toner outlet **32Y1***a*, the nozzle connection compartment **32Y1***b*, the protrusions **32Y1***e* for color discrimination, the pressed portion **32Y1***h*, and the electronic board **32Y1***f* similarly. The handle **32Y1***c* is provided on the container body **32Y2-2**.

(Third Embodiment)

A third embodiment is described below with reference to FIG. **39**.

FIG. **39** is a schematic cross-sectional view of a toner container **32Y-3** according to the third embodiment. The toner container **32Y-3** according to the third embodiment is different from the toner container **32Y** in the first embodiment in that a conveyance member **320-2** is provided in a container body **32Y2-3**.

As shown in FIG. **39**, the toner container **32Y-3** in the third embodiment includes the container body **32Y2-3** and the conveyance member **320-2** provided inside the container body **32Y2-32**. The container body **32Y2-3** is retained such a way as not to rotate by the main body **100** of the image forming apparatus **200** when the toner container **32Y-3** is installed in the toner container mount **31**.

One end of the conveyance member **320-2**, in particular, that on the bottom side, is rotatively supported by the bottom of the container body **32Y2-3**. The conveyance member **320-2** is coil-shaped. A driving input part **321** is provided on the bottom side and engages the driving coupling **91**. The

driving input part **321** may be a driven coupling, for example. With this configuration, the conveyance member **320** rotates and transports the toner inside the toner container **32Y-2** in its longitudinal direction (in FIG. **39**, to the left), receiving a driving force from the driving coupling **91** of the main body **100**. Thus, the toner is discharged through the toner outlet **32Y1***a* to the nozzle **72**.

In the third embodiment, the container body **32Y2-3** includes the toner outlet **32Y1***a*, the nozzle connection compartment **32Y1***b*, the protrusions **32Y1***e* for color discrimination, the pressed portion **32Y1***h*, and the electronic board **32Y1***f* similarly. The handle **32Y1***c* is provided on the container body **32Y2-3**. Because the container body **32Y2-3** does not rotate, a cap and the container body **32Y-3** may be united as a single unit. Needless to say, the toner container **32Y-3** may include a separate cap similarly to the first embodiment.

In the above-described second and third embodiments, the downstream end portion of the toner outlet **32Y1***a* is positioned upstream from downstream end portion of the protrusions **32Y1***e* for color discrimination in the installation direction of the toner container **32Y-2** or **32Y-3**, similarly to the first embodiment described above. This arrangement can eliminate the possibility that the toner container **32Y-2** or **32Y-3** of different color is set in the toner container mount **31** and that portion of the toner container mount **31** is stained with toner of different color.

(Fourth Embodiment)

A fourth embodiment is described below with reference to FIGS. **43** through **47**B.

The toner container **32Y-4** according to the fourth embodiment includes a cap **32Y1-4** and a container body **32Y2** similarly to the first embodiment described above.

FIG. **43** is a perspective view of the cap **32Y1-4** of the toner container **32Y-4** according to the fourth embodiment.

In the fourth embodiment, the cap **32Y1-4** of the toner container **32Y-4** includes the toner outlet **32Y1***a*, the plug **32Y3**, the pressed portion **32Y1***h*, the electronic board **32Y1***f*, the protrusions **32Y1***e* for color discrimination, the handle **32Y1***c*, and the first grooves **32Y1***g*, similarly. Further, an interlock release rib **32Y1***s* is provided in a top portion of the cap **32Y1-4**, adjacent to the electronic board **32Y1***f*.

Next, the toner container mount **31** according to the fourth embodiment is described in further detail below.

FIG. **44** is a perspective view of a bottle fixing portion **70-4** of the toner container mount **31** according to the fourth embodiment. FIG. **45** is a front view of the bottle fixing portion **70-4** as viewed on the upstream side in the installation direction of the toner container.

Referring to FIG. **44**, the bottle fixing portion **70-4**, instructed of an upper front case **701-4** and a lower front case **702-4**, includes an insertion opening **71**, a nozzle **72**, an antenna board **74**, pawl **75**, a lever **76** for fixing and releasing the toner container, and a pair of positioning protrusions **78** for each color. Additionally, the upper front case **701-4** of the bottle fixing portion **70-4** includes interlock switches **73** for the respective colors.

Referring to FIG. **45**, interiors of cap holders **71Y-4**, **71M-4**, **71C-4**, and **71K-4**, respectively defining insertion openings **71Y**, **71M**, **71C**, and **71K**, include second guide grooves **71Y2** that fit around the interlock release ribs **32Y1***s*, **32M1***s*, **32C1***s*, and **32K1***s* (shown in FIG. **43**) formed on the caps **32Y1-4**, **32M1-4**, **32C1-4**, and **32K1-4** in addition to the first guide grooves **71Y1**, **71M1**, **71C1**, and **71K1** that engage the color discrimination protrusions **32Y1***e*, **32M1***e*, **32Ce**, and **32Ke** (shown in FIG. **43**) provided on the caps **32Y1-4**, **32M1-4**, **32C1-4**, and **32K1-4**.

Next, a configuration and operation of the interlock switch **73** are described in further detail below. It is to be noted that, because the interlock switches **73** for the respective colors have a similar configuration, only the interlock switch **73** for yellow is described below.

FIGS. **46**A and **46**B are schematic top views of the interlock switch **73**. The output from the interlock switch **73** is off in FIG. **46**A and off in FIG. **46**B.

Referring to FIGS. **44** and **46**A, the interlock switch **73** provided on the upper front case **701-4** of the bottle fixing portion **70-4** includes a switch body **73***a*, a button **73***b*, a blade **73***c*, and a lever **73***d*. More specifically, the lever **73***d* of the interlock switch **73** is positioned so as to project from the second guide grooves **71Y2** as viewed on the upstream side in the installation direction of the toner container **32-4**. In other words, when the toner container **32Y-4** is inserted into the toner container mount **31**, the interlock release rib **32Y1***s*, provided on the cap **32Y1-4**, is fitted in the second guide grooves **71Y2** and contacts the lever **73***d*.

The lever **73***d* is supported on the upper front case **701-4** rotatably around an axis and is biased in the direction indicated by arrow **Y6** shown in FIG. **46**A by a spring. One end (i.e., a first end) of the blade **73***c* engages the lever **73***d*, and the other end (i.e., a second end) is supported on a side of the switch body **73***a*. The button **73***b* is provided on the side of the switch body **73***a*, at a position facing the blade **73***c*.

The button **73***b* is used to switch the output from the interlock switch **73** between on and off. The output from the interlock switch **73** is used to enable and stop or prohibit driving of the bottle driving unit **90**, data writing on the ID chip **32Y1***f*, and supply of toner. More specifically, when the output from the interlock switch **73** is off, the motor **92** of the bottle driving unit **90** is locked and is not driven. By contrast, when the output from the interlock switch **73** is on, the motor **92** of the bottle driving unit **90** is unlocked and can be driven.

Referring to FIG. **46**B, when the toner container **32Y-4** is inserted into the insertion opening **71Y-4**, the interlock release rib **32Y1***s* provided in the top portion of the cap **32Y1-4** comes into contact with the lever **73***d*. Contacting the interlock release rib **32Y1***s*, the lever **73***d* rotates around the axis clockwise in FIG. **46**B. As the lever **73***d* thus rotates, the blade **73***c* engaging the lever **73***d* is pushed toward the switch body **73***a*. Then, the blade **73***c* approaching the switch body **73***a* presses the button **73***b* provided on the side of the switch body **73***a*, thereby turning on the output from the interlock switch **73**. As a result, the motor **92** of the bottle driving unit **90** is unlocked. In this state, because the toner container **32Y-4** is set in the toner container mount **31** and the driving input parts **32Y2***b* engages the driving coupling **91**, the motor **92** can drive the container body **32Y2-4**, thereby conveying the toner inside the toner container **32Y-4** to the opening **32Y2***c*.

By contrast, when the toner container **32Y-4** is removed from the toner container mount **31**, the interlock release rib **32Y1***s* moves away from the lever **73***d* (in FIG. **46**B, downward). When the interlock release rib **32Y1***s* is disengaged from the lever **73***d*, the lever **73***d* rotates counterclockwise in FIG. **46**B around the axis, biased by the spring. As the lever **73***d* thus rotates, the blade **73***c* moves away from the switch body **73***a*, is disengaged from the button **73***b*, and returns to the position shown in FIG. **46**A. That is, the output from the interlock switch **73** is turned off, and the motor **92** is stopped. The driving coupling **91** is movable reciprocally in the installation direction of the toner container **32Y-4**. Accordingly, when the toner container **32Y-4** is removed from the toner container mount **31**, the engagement between the driving input parts **32Y2***b* and the driving coupling **91** is maintained for the distance in which the driving coupling **91** can move (see FIGS. **6** and **7**). In other words, it is possible that the driving input parts **32Y2***b* engage the driving coupling **91** even when the toner container **32Y-4** is drawn out from the insertion opening **71Y-4** the distance in which the driving

coupling **91** can move. Thus, even after the toner container **32**Y-**4** has moved a certain distance in the removal direction, the container body **32**Y**2**-**4** might be driven by the motor **92** although not intended.

In view of the foregoing, in the present embodiment, the interlock switch **73** can prohibit driving of the motor **92** during removal of the toner container **32**Y-**4** even if the driving input parts **32**Y**2***b* is in engagement with the driving coupling **91**. More specifically, the controller **101** provided in the main body **100** of the image forming apparatus **200** detects the output from the interlock switch **73** and enables driving of the motor **92** only when the output from the interlock switch **73** is on.

Further, in the fourth embodiment, data writing on the ID chip **32**Y**1***f* as well as the supply of toner (driving of the toner supply device **60**) can be enabled and stopped or prohibited by the output from the interlock switch **73**.

It is to be noted that the lever **73***d* of the interlock switch **73** is positioned downstream (dismal) from the second guide groove **71**Y**2** in the installation direction of the toner container **71**. The second guide groove **71**Y**2** has such a width (a length perpendicular to the installation direction) that the user's finger cannot fit in the second guide groove **71**Y**2** although the interlock release rib **32**Y**1***s* can fit in it. Therefore, the interlock is not unlocked unintentionally even if the user puts his/her finger in the second guide groove **71**Y**2**.

Although, in the fourth embodiment, driving of the bottle driving unit **90**, data writing on the ID chip **32**Y**1***f*, and supply of toner can be enabled and stopped or forbidden by the output from the interlock switch **73**, the output from the lever position detector **79** may be used together with that from the interlock switch **73**. In such a case, driving of the motor **92** and the like are enabled only when the controller **101** recognizes that both the lever position detector **79** and the interlock switch **73** output signals (outputs are on). By contrast, driving of the motor **92** and the like are stopped or forbidden when the controller **101** recognizes that the lever position detector **79** or the interlock switch **73**, or both do not output signals (outputs are off).

FIG. **47**A is a schematic top view that illustrates relative positions of the lever **76** and the interlock switch **73** in the installation direction of the toner container **32**Y-**4**, and FIG. **47**B is a schematic side view of the toner container **32**Y-**4**.

In FIG. **47**A, the toner container **32**Y-**4** is inserted into the toner container mount **31** from the right to the left. In FIG. **47**B, the toner container **32**Y-**4** is inserted into the toner container mount **31** from the right to the left as well.

The relative positions of the lever **76** and the interlock switch **73**, in the installation direction of the toner container **32**Y-**4**, are set such that G>F>E is satisfied wherein E represents a distance from the upstream end of the pawl **76***a* of the lever **76** to an upstream end of the lever **73***d* of the interlock switch **73**, F represents a distance from the downstream end of the sliding contact portion **32**Y**1***m* to a downstream end of the interlock release rib **32**Y**1***s*, and G represents a distance from the downstream end of the sliding contact portion **32**Y**1***m* to the edge (upstream end) of the pressed portion **32**Y**1***h* in the installation direction of the toner container **32**Y-**4**.

It is to be noted that the distance E is regarded as positive (+) when the upstream end of the lever **73***d* of the interlock switch **73** is positioned upstream (proximal) from the upstream end of the pawl **76***a* of the lever **76** in the installation direction of the toner container **32**Y-**4** and as negative (−) when it is positioned downstream (dismal) from the upstream end of the pawl **76***a* in that direction. It is to be noted that the distance F is regarded as positive (+) when the downstream end of the interlock release rib **32**Y**1***s* is positioned upstream (proximal) from the downstream end of the sliding contact portion **32**Y**1***m* in the installation direction of the toner container **32**Y-**4** and as negative (−) when the downstream end of the interlock release rib **32**Y**1***s* is positioned downstream (dismal) from the downstream end of the sliding contact portion **32**Y**1***m* in that direction. The distance G is regarded as positive (+) when the upstream end of the pressed portion **32**Y**1***h* is positioned upstream (proximal) from the downstream end of the sliding contact portion **32**Y**1***m* in the installation direction of the toner container **32**Y-**4** and as negative (−) when the upstream end of the pressed portion **32**Y**1***h* is positioned downstream (dismal) from the downstream end of the sliding contact portion **32**Y**1***m* in that direction.

In the arrangement in which the distance F is greater than the distance E (F>E), the interlock release rib **32**Y**1***s* does not contact the lever **73***d* of the interlock switch **73** even when the toner container **32**Y-**4** is at a position where the downstream end of the sliding contact portion **32**Y**1***m* comes into contact with the pawl **76***a* (as shown in FIG. **14**) during installation of the toner container **32**Y-**4**. In this state, the interlock switch **73** does not output signals (output is off) even though the lever position detector **79** outputs a signal (output is on). Therefore, driving of the motor **92**, the data writing on the ID chip **32**Y**1***f*, and supply of toner can be prevented until the toner container **32**Y-**4** is secured in the toner container mount **31**. In particular, in the state shown in FIG. **14**, the toner container **32**Y-**4** can move because the first grooves **32**Y**1***g* do not yet fit around the positioning protrusions **78**. If data is written in or read out from the electronic board (ID chip) **32**Y**1***f* in this state, it is possible that the electronic board **32**Y**1***f* is moved outside the communicational area of the antenna board **74** during data writing or reading, resulting in a communication error. Thus, the electronic board **32**Y**1***f* or the antenna board **74**, or both can be damaged seriously.

In view of the foregoing, in the fourth embodiment, the relative positions of the toner container **32**Y-**4** and the toner container mount **31** are set so that the distance F is greater than the distance E (F>E). With this arrangement, rotation of the toner container **32**Y-**4** and data writing and reading from the electronic board **32**Y**1***f* can be executed only after the toner container **31**Y-**4** is secured in the toner container mount **31**.

Additionally, because the distance G is greater than the distance F (G>F), the output from the lever position detector **79** can become on only after the output from the interlock switch **73** is turned on and the toner container **32**Y-**4** is secured in the toner container mount **31**. Accordingly, driving of the toner container **32**Y-**4** (motor **92**) and data writing and reading from the electronic board **32**Y**1***f* can be enabled only after the toner container **32**Y-**4** is secured in the toner container mount **31**.

Table 2 illustrates relations among time of the various operations, on and off states of outputs from the detectors, and the movements of the respective components in the fourth embodiment.

TABLE 2

Operational timing	Lever position detector	Interlock switch	Toner container rotation	Writing on electronic board	Screw pump driving
Toner container secured	ON	ON	Permitted	Permitted	Permitted
Lever released	OFF	ON	Prohibited	Prohibited	Prohibited
Toner container removed	ON	OFF	Prohibited	Prohibited	Prohibited
Installation of	OFF	Switched	Prohibited	Prohibited	Prohibited

TABLE 2-continued

Operational timing	Lever position detector	Interlock switch	Toner container rotation	Writing on electronic board	Screw pump driving
new container started		to ON			
New container secured	ON	ON	Permitted	Permitted	Permitted

Referring to table 2, when the toner container **32Y-4** is secured at the installation position in the toner container mount **31**, the output from the lever position detector **79Y** is on and the interlock switch **73** is on. In this state, any of rotation of the toner container **32Y-4**, data writing on the IC chip (electronic board) **32Y1***f*, and driving of the screw pump **61** is permitted as required. When the lever **76** is released to remove the toner container **32Y-4** from the toner container mount **31**, the output from the lever position detector **79** is turned off. In this state, rotation of the toner container **32Y-4**, data writing on the IC chip (electronic board) **32Y1***f*, and driving of the screw pump **61** are stopped compulsively or forbidden even when the interlock switch **73** is on. When the toner container **32Y-4** is removed and is not present in the toner container mount **31**, the output from the lever position detector **79** is on and the interlock switch **73** is off. In this state, rotation of the toner container **32Y-4**, data writing on the IC chip (electronic board) **32Y1***f*, and driving of the screw pump **61Y** are yet forbidden. Additionally, when a new (used or unused) toner container **32Y-4** is being inserted into the toner container mount **31**, the output from the lever position detector **79** is off and the interlock switch **73** is switched from off to on. Because insertion of the toner container **32Y-4** is not yet completed even when the interlock switch **73** is turned on, the output from the lever position detector **79** remains off. Accordingly, rotation of the toner container **32Y-4**, data writing on the IC chip (electronic board) **32Y1***f*, and driving of the screw pump **61Y** are yet forbidden. When the new toner container **32Y-4** is set at the installation position, both the output from the lever position detector **79** and that from the interlock switch **73** are on. Therefore, rotation of the toner container **32Y-4**, data writing on the IC chip (electronic board) **32Y1***f* and driving of the screw pump **61Y** are permitted as required.

Next, a flow of processes for setting the operation enabling flag performed by the controller **101** according to the fourth embodiment is described below.

FIG. **51** is a flowchart that illustrates a sequence of processes for setting the operation enabling flag by the controller **101** of the image forming apparatus **200** according to the fourth embodiment.

The operation enabling flag setting is performed repeatedly, independently for each of yellow, cyan, magenta, and black when a main power of the image forming apparatus **200** is on. At S**31** the controller **101** checks the output from the lever position detector **79** and, at S**32**, checks the amount of toner remaining in the toner container **32Y-4**. The controller **101** checks the amount of the remaining toner based on the data relating to that stored in the ID chip (electronic board) **32Y1***f*. When the output from the lever position detector **79** is on (Yes at S**31**) and it is recognized that the amount of remaining toner is sufficient (Yes at S**32**), at S**33** the operation enabling flag is turned on. In other cases, at S**44** the operation enabling flag is turned off. It is to be noted that, when the toner container **32Y** is not set in the toner container mount **31**, the amount of remaining toner cannot be retrieved from the ID chip **32Y1***f* (read error), and thus the controller **101** regards the amount of remaining toner as insufficient (No at S**32**).

In the fourth embodiment, because the amount of remaining toner is checked in the operation enabling flag setting shown in FIG. **51**, the amount of remaining toner is not checked in the flow for allowing or forbidding driving of the screw pump **61** or rotation of the toner container **32Y-4**. Thus, the control flow can be simplified.

Table 3 illustrates relations among time of the various operations, on and off states of outputs from the detectors, and the movements of the respective components.

TABLE 3

Operational timing	Lever position detector	Amount of Toner	Screw pump driving
Toner container secured (with toner)	ON	Sufficient	Permitted
Toner container secured (without toner)	ON	Insufficient	Prohibited
Lever released	OFF	Sufficient or Insufficient	Prohibited
Toner container removed	ON	Not available (Insufficient)	Prohibited
Installation of new container started	OFF	Changed from "insufficient" to "sufficient"	Prohibited
New container secured	ON	Sufficient	Permitted

When the toner container **32Y-4** is retained at the installation position and the amount of remaining toner is regarded as sufficient (Yes), the output from the lever position detector **79** is on. In this state, any of rotation of the toner container **32Y-4**, data writing on the IC chip (electronic board) **32Y1***f*, and driving of the screw pump **61** is permitted as required. Even when the output from the lever position detector **79** is on, driving of the toner container **32Y-4**, data writing on the IC chip (electronic board) **32Y1***f*, and driving of the screw pump **61** are prohibited when no toner is present in the toner container **32Y-4** or the amount of remaining toner is insufficient (No at S**32** in FIG. **51**). When the lever **76** is released to remove the toner container **32Y-4** from the toner container mount **31**, the output from the lever position detector **79** is turned off. In this state, rotation of the toner container **32Y-4**, data writing on the IC chip (electronic board) **32Y1***f*, and driving of the screw pump **61** are stopped compulsively or forbidden even when the amount of remaining toner is regarded as sufficient. When the toner container **32Y-4** is removed and is not present in the toner container mount **31**, the output from the lever position detector **79** is on and the amount of remaining toner is regarded as insufficient. In this state, rotation of the toner container **32Y-4**, data writing on the IC chip (electronic board) **32Y1***f*, and driving of the screw pump **61** are yet forbidden. Additionally, when a new (used or unused) toner container **32Y-4** is being inserted into the toner container mount **31**, the output from the lever position detector **79** is off and the determination of the amount of remaining toner is switched from "insufficient" to "sufficient". Because insertion of the toner container **32Y-4** is not yet completed even when the amount of remaining toner is regarded as sufficient, the output from the lever position detector **79** remains off. Accordingly, rotation of the toner container **32Y-4**, data writing on the IC chip (electronic board) **32Y1***f*, and driving of the screw pump **61** are yet forbidden. When the new toner container **32Y-4** is set at the installation position, the output from the lever position detector **79** is on and the amount of remaining toner is regarded as sufficient. Therefore, rotation of the toner container **32Y-4**, data writing on the

IC chip (electronic board) **32**Y**1***f*, and driving of the screw pump **32**Y are permitted as required.

It is to be noted that, in the present embodiment, the outputs from the lever position detector **79**, the antenna board **74**, and the interlock switch **73** may be used in combination in the above-described control. In such a case, driving of the motor **92** and the like are enabled only when the controller **101** recognizes that all of the lever position detector **73**, the antenna board **74**, and the interlock switch **73** output signals (outputs are on). By contrast, driving of the motor **92** and the like are stopped or forbidden when the controller **101** recognizes that any of the lever position detector **79**, the antenna board **74**, and the interlock switch **73** does not output signals (outputs are off).

In a configuration in which the outputs from the lever position detector **79**, the antenna board **74**, and the interlock switch **73** are used in combination, it is preferable that the relative positions shown in FIGS. **41**A and **41**B (A>B), those shown in FIGS. **42**A and **42**B (D>C), and those shown in FIGS. **47**A and **47**B (G>F) be satisfied as well. With this arrangement, even in a case of a malfunction of any of the lever position detector **79**, the antenna board **74**, and the interlock switch **73** and the output is erroneous, driving of the toner container **32**Y-**4** (motor **92**), data writing and reading from the electronic board **32**Y**1***f*, and the like can be controlled reliably.

It is to be noted that, although the toner containers **32** contain powder toner in the above-described first to fourth embodiments, alternatively, the toner containers **32** may contain two-component developer consisting essentially of toner and carrier to be used in image forming apparatuses that use two-component developer. In such a configuration, effects similar to those attained in the above-described embodiments can be also attained.

Further, at least one of the components of the image forming unit **3** may be held together with the photoreceptor drum **1** in a common unit casing, that is, the image forming unit **3** may be configured as a process cartridge removably insertable into the main body **100**. In such a configuration, effects similar to those attained in the above-described embodiments can be also attained.

The number, position, shape of the components of the image forming apparatus described above are not limited to those described above.

Numerous additional modifications and variations are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the disclosure of this patent specification may be practiced otherwise than as specifically described herein.

What is claimed is:

1. An assembly, comprising:

a container mount, in which a powder container for containing powder and having a powder outlet is removably installed;

a container driving unit to drive the powder container at least partially to discharge the powder from the powder container through the powder outlet;

a container detector to detect whether the powder container is set at an installation position in the container mount;

a retainer movable between a retaining position to retain the powder container at the installation position in the container mount and a release position to unlock the powder container from the installation position;

a retainer detector to detect whether or not the retainer is at the retaining position; and

a controller, operatively connected to the container detector as well as the retainer detector, to permit or prohibit driving of the container driving unit based on a combination of a detection result generated by the container detector and a detection result generated by the retainer detector,

wherein the container detector comprises an interlock positioned in the container mount, the interlock having a button on one side thereof, and

wherein the powder container further comprises an interlock contact portion that contacts the button of the interlock when the powder container is set at the installation position in the container mount.

2. The assembly according to claim **1**, further comprising:

a powder conveyance tube through which the powder discharged from the powder container is conveyed to a destination in an image forming apparatus;

a pump to convey the powder through the powder conveyance tube to the destination in the image forming apparatus; and

a pump driving unit to drive the pump,

wherein the controller permits or prohibits driving of the pump driving unit based on a combination of the detection result generated by the container detector and the detection result generated by the retainer detector.

3. The assembly according to claim **1**, wherein the powder container further comprises a memory for storing data relating to the powder container, communicably connected to the controller, and the container detector detects whether communication with the memory is established to determine whether or not the powder container is set at the installation position in the container mount.

4. An image forming apparatus comprising:

the assembly according to claim **1**, for containing toner;

an image bearer; and

an image forming unit to form a toner image on the image bearer and to which the toner is supplied by the assembly.

* * * * *